

# Speed & Power

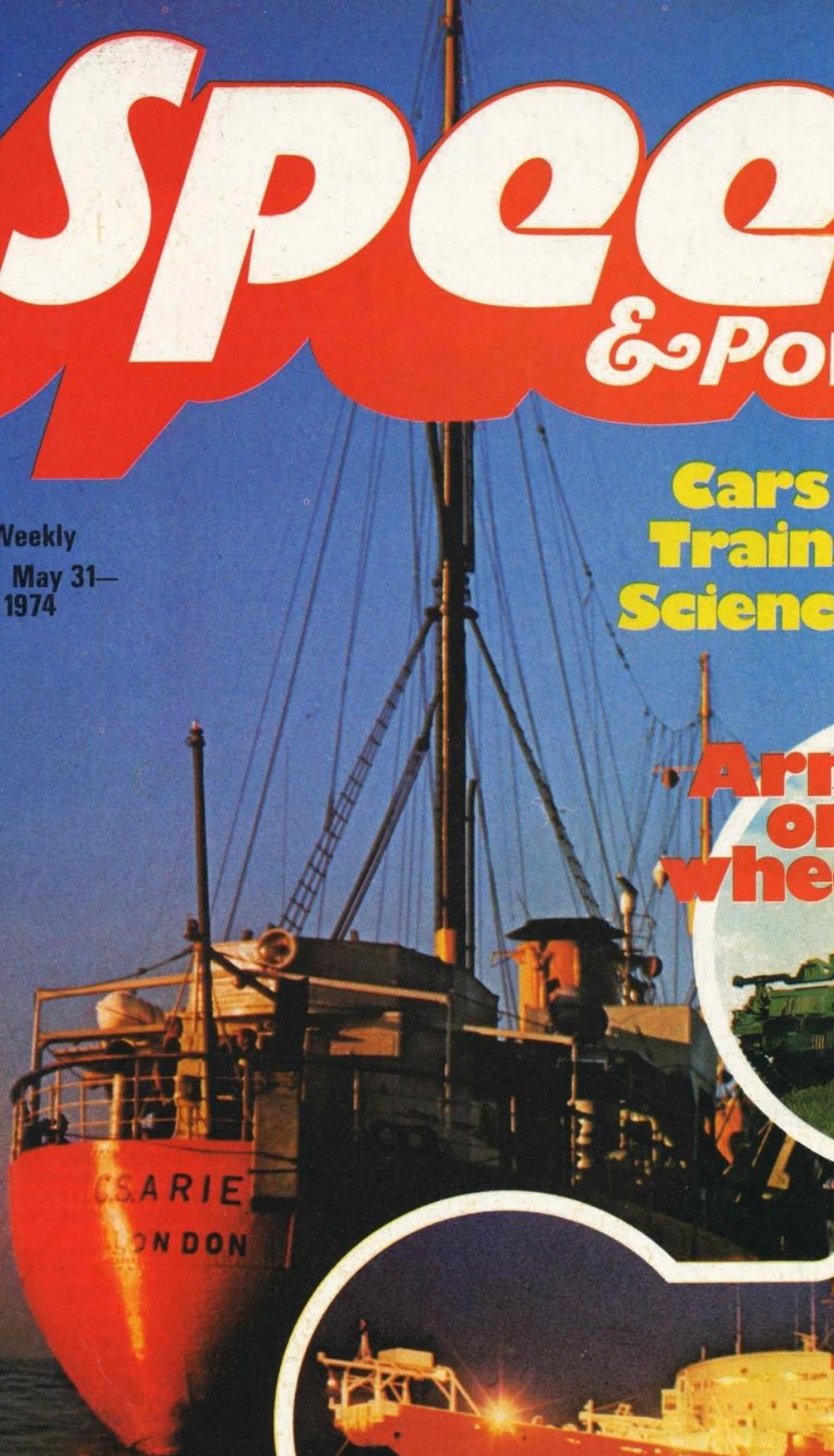
10p Weekly  
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**Cars Planes  
Trains Space  
Science Fiction**

**Army  
on  
wheels**



**Cable  
ships**





A FLEET of Jumbo jets armed with Intercontinental Ballistic Missiles (ICBM) may soon be patrolling the skies over America if the United States Air Force has its way. The USAF and Boeing, who make the civil 747 Jumbo jet, are studying heavier and stronger versions known as the MC-747, which could stay in the air almost all day, ready to launch their missiles if the United States were attacked.

This idea is the latest in a series aimed at reducing the

possibility of land-based ICBMs being destroyed during a surprise attack. At the moment America has a thousand Minuteman missiles which can reach important parts of potential enemies. These missiles carry up to three warheads, each ten times as powerful as the atomic bomb, which was dropped on Hiroshima to end Japanese participation in World War II. These missiles, and more than fifty of the much bigger but older Titan, are kept in underground silos for protection and can be launched at a moment's notice. Because they have to remain in one position, however, the Russians always know where they

are—thanks to their spy satellites—and the USAF is afraid that its missile force could be destroyed without warning.

Other suggestions, before the MC-747 was thought of, included keeping the ICBMs in silos carved out of solid rock hundreds of feet thick, or mounting the missiles on railway wagons so that they could be kept moving during an emergency.

A missile-carrying Jumbo jet would be very similar to the civil 747 operated by the world's airlines but would be specially strengthened to take a heavy load of ICBMs instead of passengers. A force of 36 aircraft would be needed, half based on

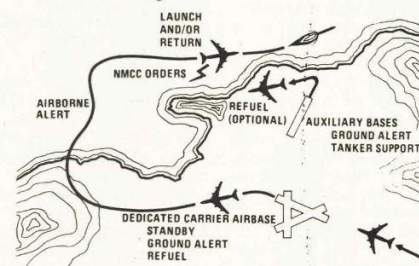
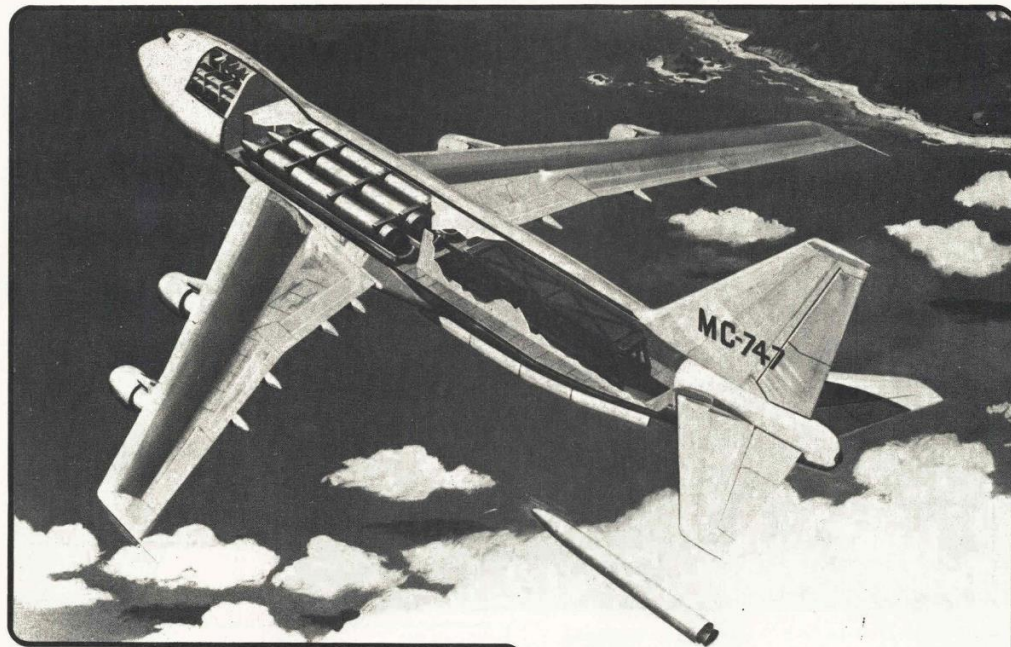
one side of America and the rest operating from the other side, with about 25 being in the air at any time.

The aircraft would weigh 400 tons at take-off and would be refuelled in flight by 12 other Boeing 747's converted to aerial tankers, raising the weight to nearly 550 tons and allowing the mission to last nearly all day without landing. The four missiles would be kept in the cabin where the passengers normally sit, after being loaded through a nose door with a flip-

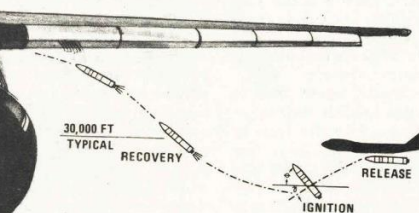


# The JUMBO goes to war

In this age of super-missiles, an equally powerful aircraft is needed to carry and launch them if necessary. The Jumbo Jet could well be the answer.

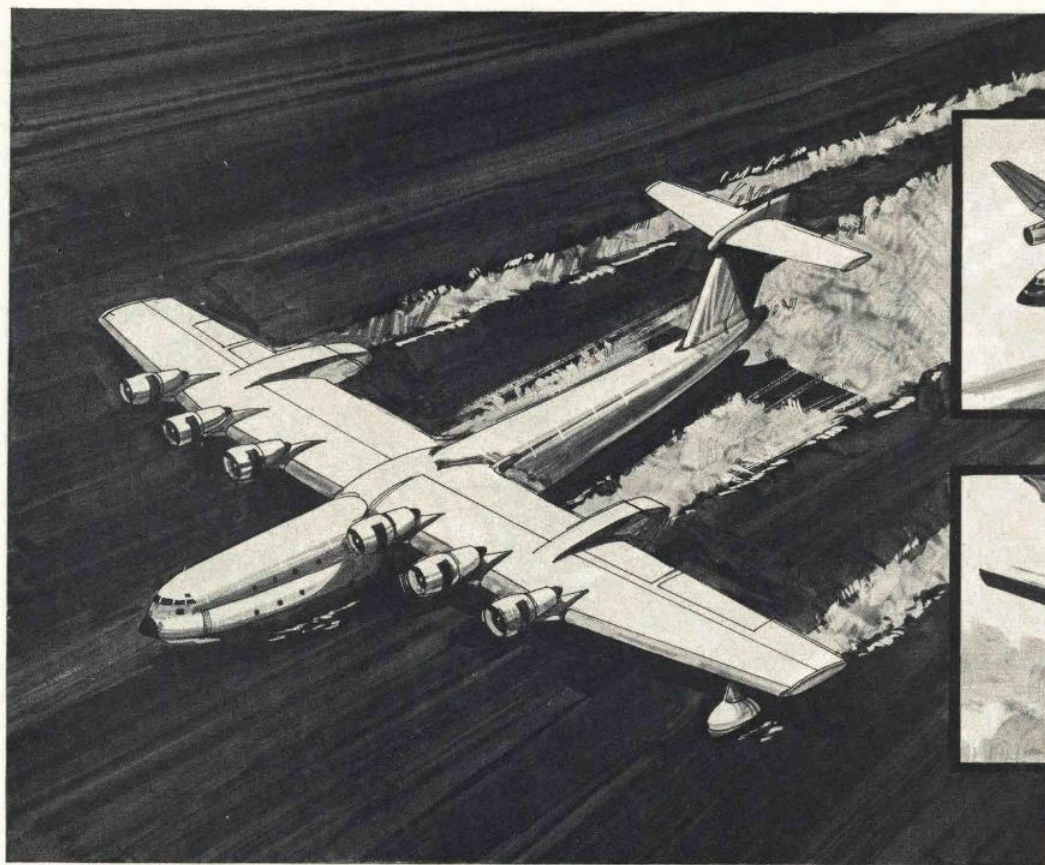


Top: An artist's cut-away impression of the proposed Boeing MC-747, showing giant missiles loaded where passengers would normally sit. Above: How the 747 missile carriers would operate.



Above: The airborne carriers could launch missiles, which would power away once clear of the aircraft.





up visor like that on the Lockheed C-5, the biggest aircraft in the world (see *SPEED & POWER*, Issue No. 1).

Two men would sit at a launch-control desk in the aircraft, ready to fire the missiles if the "go code" from headquarters told them to. Both men would have to move at the same time to operate the firing controls, so that one man by himself could not launch the missiles if he had an attack of insanity!

The four ICBMs, each weighing nearly 50 tons, would be dropped out of the back of the Jumbo jet while it was flying at about 30,000ft. A special device would control the missiles as they fell, to make sure that they were pointing upwards at about 45 degrees. The missile power units would be started once clear of the launch aircraft.

The missiles would then be accelerated towards their target more than 6,000 miles away by three sets of motors, each stage separating and falling away after its fuel had been used up. Very accurate navigation systems in the missile nose would keep it on course, and correction signals could be sent from the aircraft.

**Above: A giant amphibious missile carrier is also a possibility. Insets: Proposed four and six-engined ICBM-carrying aircraft**

After launching its missiles the Jumbo would return to base for reloading or, if its home airfield had been destroyed, would fly to another which had remained undamaged.

Boeing have suggested other aircraft as well as the MC-747 for launching ICBMs. Most have very long, straight wings and are built of very light materials so that more of the total weight can be taken up by the missile load. One project would weigh nearly 700 tons after refuelling in the air, while another would have missiles in pods under its wings, the fuselage holding the crew.

An even more way-out scheme is a huge amphibious aircraft which could sit on the sea for days at a time, then move to a new patch of ocean to remain undetected. The engines would have to be mounted on the top of the wings so that salty water would not be thrown into them, and the missile would be launched sideways from bomb bays above the waterline.

**SPECIAL**

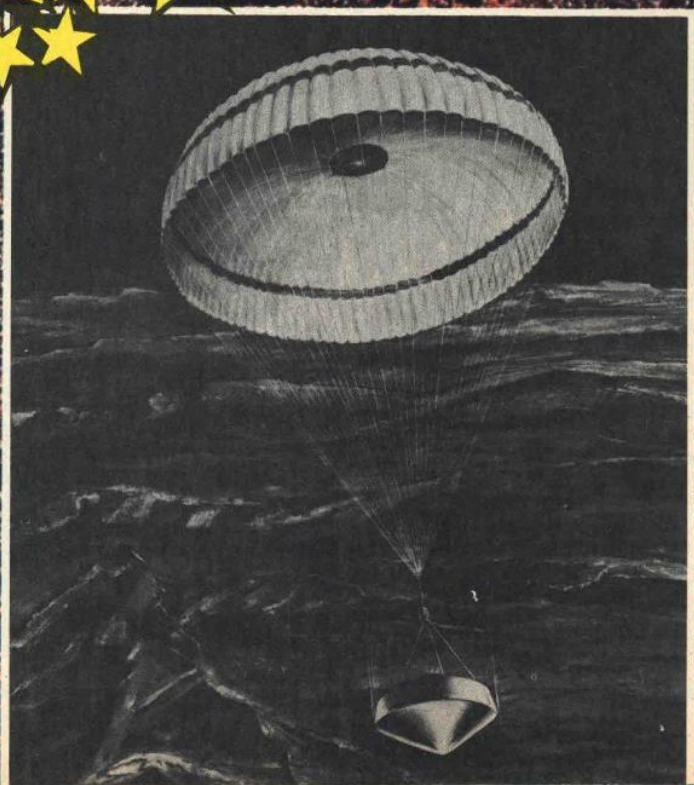
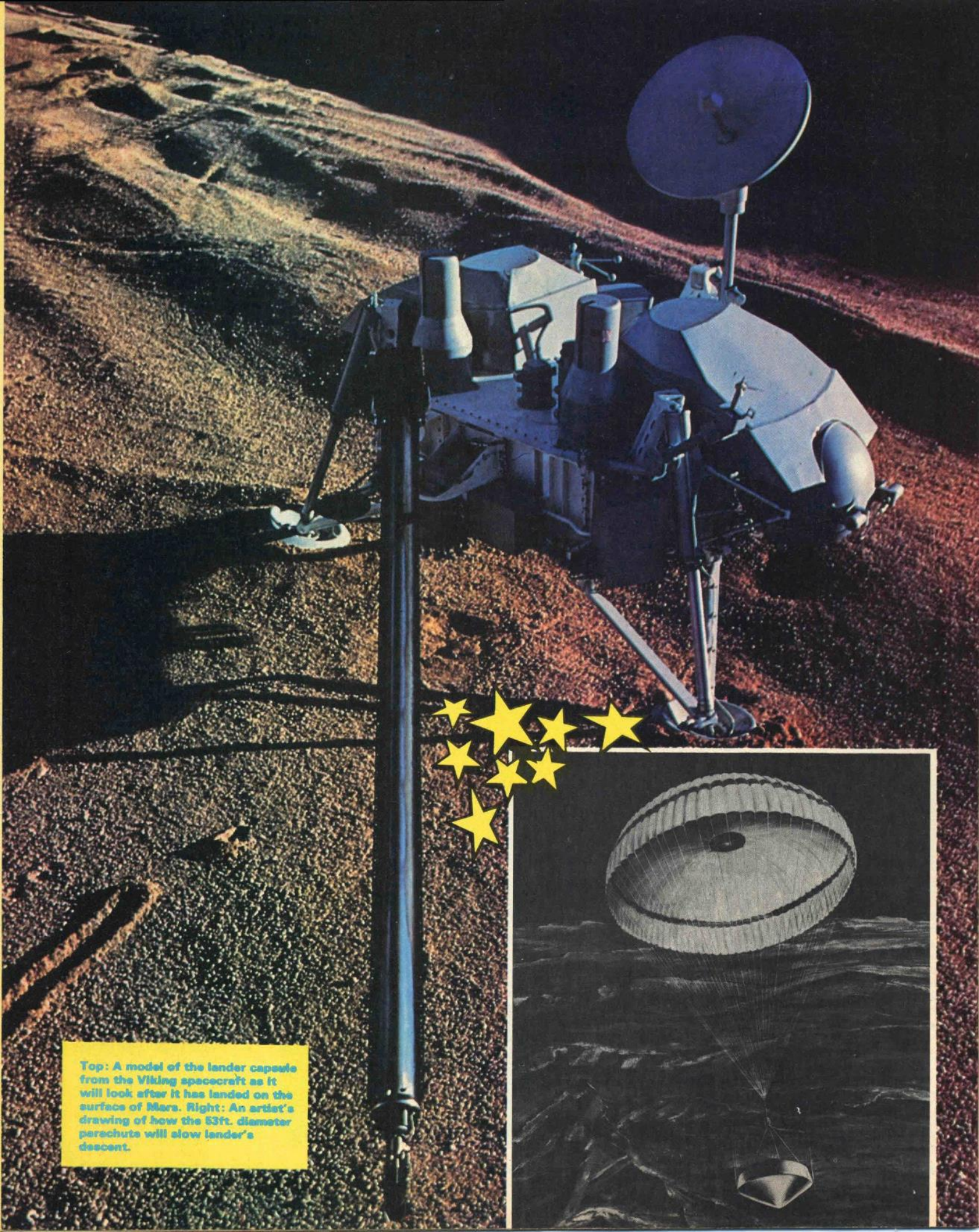
**10p**

**ALL-WORLD STAMPS 131**

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**BROADWAY APPROVALS**  
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Top: A model of the lander capsule from the Viking spacecraft as it will look after it has landed on the surface of Mars. Right: An artist's drawing of how the 53ft. diameter parachute will slow lander's descent.



# Viking

## The Mars Explorer

*The Red planet is still shrouded in mystery. American space experts are determined to "invade" it with a robot spacecraft—but the problems are immense.*

**R**EMEMBER our story of the super marksmen of the space age? The mission controllers who, with computers to help, can score a bull's-eye almost every time they aim a spacecraft at a moving planet millions of miles away. If you've forgotten it look up Issue No. 3 of *SPEED & POWER*.

O.K. Now let's move to the other end of the journey. Let's say that Mars is the target and that a spacecraft from Earth has gone into orbit round the planet after a journey lasting nearly a year. There are no men on board, only delicate scientific instruments. The problem is how to land the automated craft without mishap so that it can relay back to Earth the findings of its various experiments.

Complicated? You bet it is. Far more difficult, it would seem, than to do the same thing on the Moon. So far only the Russians have tried it; and though they landed and operated their Lunarkhod Rover on the Moon with great success, they were less lucky with Mars. Two attempts to soft-land an instrumented package have not gone as planned.

The Americans have taken marvellous pictures of the Red Planet from craft in Martian orbit, but have so far not attempted a landing. Their planned exploration of the Red Planet's surface by twin Viking craft is still two years away.

One of the biggest headaches for them is the communications delay which occurs when a spacecraft operating millions of miles from its control base. Messages from spacecraft orbiting Mars take 40 minutes to reach Earth, and

another 40 minutes is needed to radio a reply back. So if there is a breakdown during the landing sequence, ground-based engineers at Mission Control will be powerless to help. Even if they know how to fix the trouble, their instructions will arrive too late.

Another big problem is the rarified atmosphere of Mars, which is thinner than at the top of Mount Everest. A landing vehicle has first to be checked and steadied by parachute before braking rockets take over to control landing speed and touchdown. But how do you get a parachute to operate in such a thin atmosphere?

To answer this single question American space scientists mounted a major research programme, lifting specially-designed parachutes to a height of 23 miles by means of giant balloons. Two balloons, employed in tandem, were used for each launch. The launch balloon, which lifted the payload off the ground, was an impressive 100 feet in diameter. But it was dwarfed by the main balloon, a giant of 446 feet in diameter which, when fully inflated, would have room inside for a 40-storey skyscraper. At launch it looked something like a gigantic rolled umbrella, in a container that was zipped open in flight. A lot of work was involved with the parachute, but the scientists got the information they were seeking.

NASA scientists are working at full stretch on the Viking Lander's computer—a really vital component in what is shaping up as the most automated space mission ever attempted.

The first of the two Vikings is to be launched in August, 1975, with the second identical craft following a week or two later. At that time the planet will be within range for a period of 40 days. If all is not ready for blast-off within that 'launch opportunity' period, there will be a delay of 25 months before another attempt can be made.

If all goes well, Viking 1's Lander Module could touch down around July 4, 1976—just in time to celebrate the 200th birthday of the United States. Its Orbiter Module will continue to circle Mars and to act as a relay station for information transmitted back to Earth. Viking 2 will operate in exactly the same way, from another area of the planet.

Each Lander is being designed to function as a miniature geochemical laboratory, a weather station, an earthquake recording unit and—most important of all—a biological laboratory capable of detecting life forms that may exist on the Red Planet.

**VIKING MISSION SEQUENCE**  
After launch by the Titan III/Centaur rocket: (1) Solid rocket motor separation. (2) Stage 1 separation. (3) Stage 2 separation. (4) Centaur burn, parking orbit, 2nd burn. (5) Bioshield cap jettison. (6) Centaur deflection. (7) Space flight 305 to 360 days. (8) Mars orbit insertion. (9) Orbiter. (10) Lander capsule separation. (11) De-orbit. (12) Entry at 800,000ft. (13) Parachute deployment 20,000ft. and Aeroshell jettison. (14) Terminal descent 4,000ft. (15) Entry to landing 5 to 10 minutes.





# THE MONORAIL DREAM

Monorails are older than you may think, yet there are only a handful of these systems actually operating. So why aren't there more? Is it because they are too unconventional compared with ordinary railways? Many people think that the monorail has a part to play in the cities of the future.

**A**LMOST since the first railway was laid well over 150 years ago, the men who plan and design railways have cherished a dream—the dream of a cheap, high-speed railway which could be run on a single rail instead of the normal two. That dream became a reality—if rather a primitive one, in 1824, when H. R. Palmer built what is believed to be the first mono railway—hailed by horses! It was used in the London Docks, and its appeal in those days was not that it was fast, but that it was cheap to build and maintain.

The greatest problem of designing a monorail then—and now—was making the trains stable. The earliest principle, used by Palmer, was to balance the load by making the wagons similar to the panniers on the back of a packhorse. The wagon container was in two parts, one either side of the wheels, slung below the level of the track. The load had to be balanced so that the wagon could be hauled along steadily.

This was satisfactory when the wagon was horse-drawn and slow, but when horses were replaced by horse-power and movement was speeded up, difficulties arose. So then inventors put steadying tracks either side of the monorail, which proved quite effective. A number of light railways were designed on this principle, notably Lartigue's railways, the most famous of which was the Listowel and Ballybunion Railway in Ireland. But, of course, once the

steadying rails were introduced, the lines really ceased to be true mono systems.

The simplest way to keep vehicles steady when they run on a single line is to hang them *below* the track. This may involve some problems in building the overhead track, but these are fairly easily solved and a number of inventors have designed railways of this kind. The outstanding example is the Barmen and Elberfeld Railway in Germany invented by Eugen Langen, opened in 1901. For most of its 8½ miles, the overhead track straddles the River Wupper. Providing a passenger service between Barmen and Elberfeld, the trains consist of only two coaches. The signalling is automatic and the average speed is only 25 kilometres per hour (about 15½ mph), but the service is steady and dependable even in bad weather, and the line has an astonishing record of safety and reliability. Damaged by air raids during World War II, it was repaired as quickly as possible in 1946, and it is today the classic example of a successful public mono railway.

The most exciting kind of mono railway consists of a single line along which streak streamlined, gyroscopically-stabilised coaches! A space-age idea for the future you might say. But you would be wrong by 70 years! A gyro-car was patented in 1903 by Louis Brennan, an Irish engineer who was born in Castlebar, County Mayo, in 1852. Brennan's invention was one of the most dramatic in the history of mono railways. He built a remarkable vehicle which ran on two two-wheeled bogies. The bodywork was rather like a motor truck with a flat platform at the back. It was driven by two petrol engines through an electric transmission and was stabilised by two gyroscopes,

each 3ft. 6in. in diameter and weighing 15cwt, which rotated at 3,000 rpm. In the event of a power failure, they could continue to spin on their own momentum and steady the vehicle for several hours!

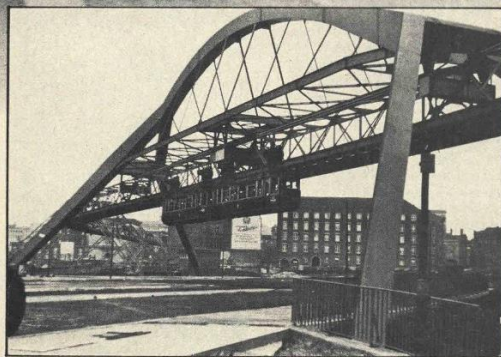
Brennan was employed at a workshop involved in defence work and he considered his invention to be of greatest use for military purposes to carry supplies from base to just behind the front lines. The single track could be prefabricated and laid or taken up very quickly. It needed only the minimum preparation of a bed on which it could be laid, and could have been repaired very quickly if damaged by enemy action.

Brennan demonstrated a full-size car on a track which was laid at Gillingham in Kent. This was a circle of ¼-mile circumference approached by a 400-yard straight run. The car was extremely stable, could carry 10 tons, and it banked automatically when run round a curve. If a heavy load was put on one side, far from unbalancing it, that side actually rose as the gyroscopes counterbalanced it! Though it was shown on the Continent and in America, this apparent breakthrough came to nothing.

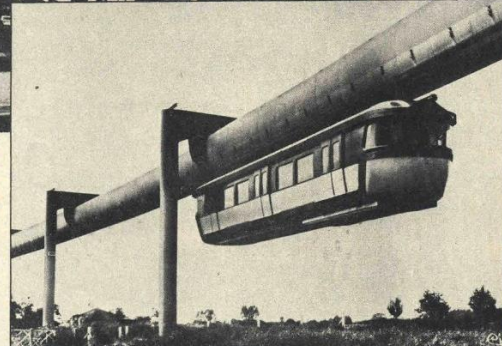
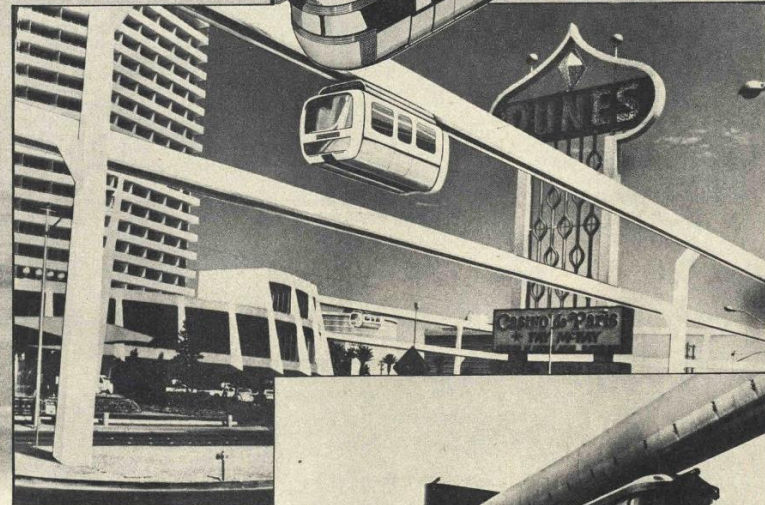
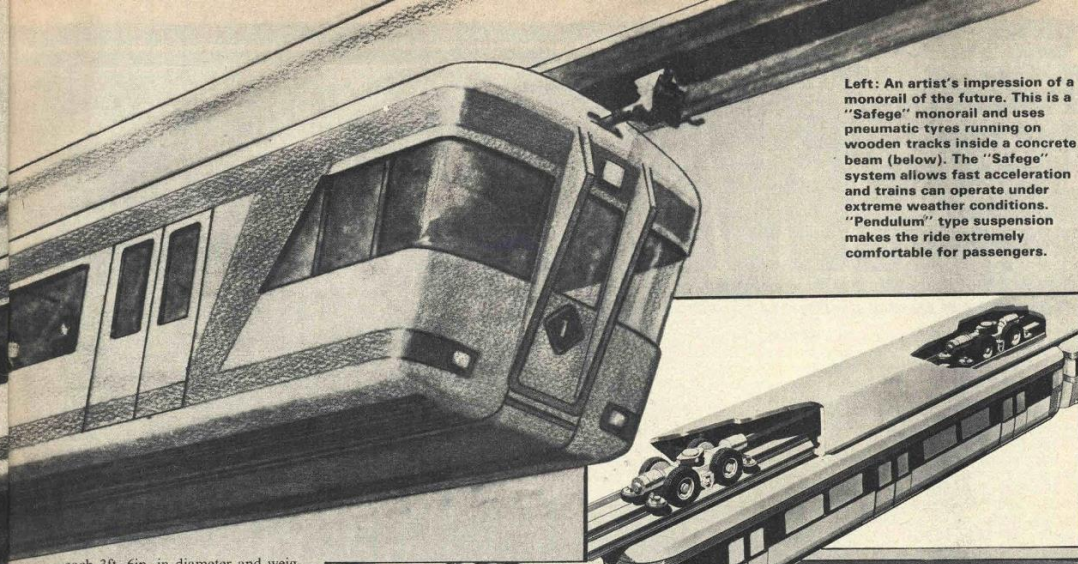
Despite its long history and all the advantages it offers in today's world, the monorail has literally never really "got off the ground". The reasons given for this are varied in detail but, in fact, they are all basically the same—money!

Monorails are so utterly different from conventional railways that neither financiers nor governments will take the risk of investing money in them. They cannot, for instance, be integrated into the normal railway system, but can only supplement it. They can take only passengers and lightweight freight—and, in the past, much more money has been made on heavy freight. At present, at any rate, they are really suitable only for straight runs without sidings or

Left: An artist's impression of a monorail of the future. This is a "Safege" monorail and uses pneumatic tyres running on wooden tracks inside a concrete beam (below). The "Safege" system allows fast acceleration and trains can operate under extreme weather conditions. "Pendulum" type suspension makes the ride extremely comfortable for passengers.



Above: Oldest commercial monorail still in operation is the Barmen and Elberfeld Railway in Germany, which was opened in 1901. Fortunately, monorails of the future would not need such extensive support structures!



Centre: A photo-impression of a monorail-cab system planned for Las Vegas. Bottom: A "Safege" monorail at speed during tests on a French test track.

Photos: Railway Gazette International and Taylor Woodrow



# AWACS

## Airborne Warning And Control System

*Innocent-looking, if odd—but these converted airliners will soon be acting as sentinels to give advanced warning of a threat to the United States.*

THE CENTURION on the Roman wall looked out over the rolling hills and watched a hawk circling high above the ridges. "If only I could be that hawk," he thought, "I would be able to see the Barbarians farther away than a day's march."

Commanders of defending armies throughout the ages have wished they could see over the hills, down into the valleys and beyond the mountain ranges. Today more than ever, to know well in advance the type, direction, speed and size of a threat is a weapon in itself—it could mean the difference between survival and disaster.

During the 1950s and 1960s, the Russians and Americans built chains of massive ground radar stations to warn of the approach of high-flying aircraft and missiles. But because the surface of the Earth is curved, the radar equipment could only see as far as the horizon. Although both countries developed sophisticated techniques to bounce radar waves off the upper atmosphere to look over the horizon, the fixed radar chains were not really satisfactory for warning of the approach of yet another threat—from low-flying aircraft which could slip in below the radar's field of view. Even now, ground-based radar's are not very effective against low-flying aircraft.

In the mid-1960s, the United States Air Force became interested in the idea of mounting a large radar on a big aircraft to get a better view. Although this idea sounds pretty obvious, in practise it isn't easy. Downward-looking radar is fine for mapping or picking out fixed targets like bridges but the intensity of the reflections from the ground make it difficult to spot low-flying aircraft at anything but short ranges. (Radar works by sending out radio waves, then analysing the reflections which are bouncing back.) It took a number of years of work—and quite a lot of money—to develop a radar suitable for this job of airborne early warning.

The second important task for the airborne radar is to provide an aerial command post to control complete battle areas and direct friendly fighters and bombers towards their targets. Unlike fixed ground radar's, this new system is difficult to track and therefore difficult for the enemy to knock out.

The USAF called the combination of radar and aircraft the Airborne Warning and Control System

(AWACS for short). The USAF was anxious to try out the idea as soon as possible and so, in 1970, the Boeing plane-makers were asked to modify two of their 707 airliners to carry radar scanners in big 30ft.-diameter radomes mounted above the rear of the fuselage. Westinghouse, another American firm, expert in electronics, were also asked to supply radar equipment for the aircraft.

In its new job as a flying station, the 707 will be known as the E-3A. The exact performance of AWACS is a classified secret but it is probably able to survey the surface of the Earth in directions for about 250 miles—enabling it to keep a close watch on some 200,000 square miles! At greater ranges than 250 miles, the curvature of the Earth takes the surface out of view; AWACS, however, can still keep tabs on aircraft flying at medium and high altitudes at ranges greater than this.

The name Rotodome has been

coined to describe the saucer-shaped radome mounted atop the E-3A's rear fuselage. It has to be saucer-shaped to minimise aerodynamic drag (the E-3A cruises at about 450mph) and is designed to rotate as the radar aerial inside swings round through 360 degrees to scan the horizon. The Rotodome rotates at either one quarter of a revolution a minute or at six revolutions per minute.

The fuselage of the E-3A is packed with "black-boxes" (instruments) to aid navigation and with communications equipment to keep its crew in touch with other aircraft and with service chiefs on the ground.

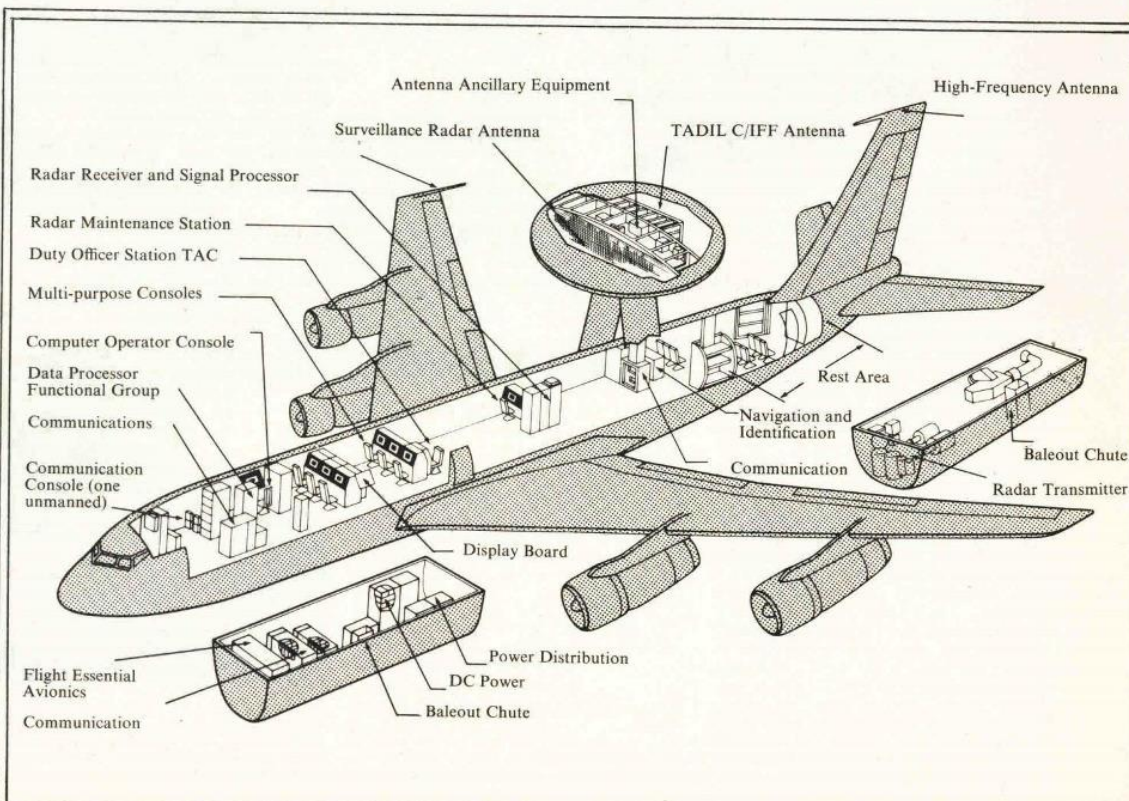
All the information received by the AWACS radar is collected, sorted and analysed with the aid of a powerful IBM computer installed in the cabin just behind the cockpit. This information is then plotted on a number of big radar screens so that the crew and the airborne commander

can see exactly what is happening.

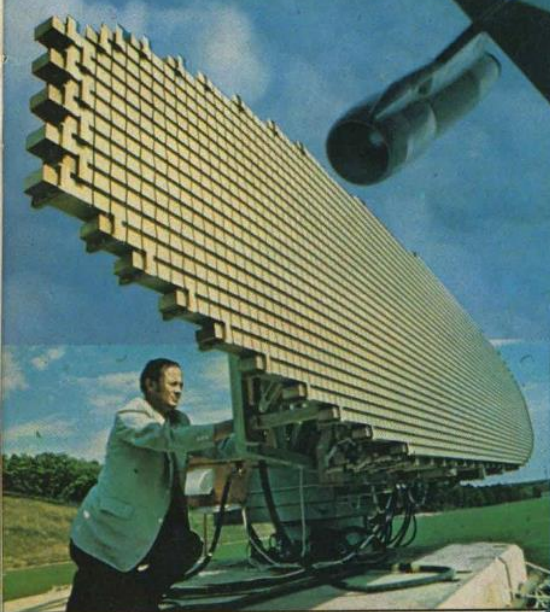
There is one problem, however.... How does AWACS tell whether the aircraft it picks up are friendly or not? These days, most military combat aircraft are fitted with Identification, Friend or Foe (IFF) equipment. When the AWACS radar detects an unidentified aircraft, the IFF equipment mounted in the back of the Rotodome sends out a coded message. The IFF equipment of the friendly aircraft receives the signal and replies, again in code, with an identification number and some details of its flight path. This information is stored in the E-3A's computer and displayed beside a corresponding blip on the radar screen. Because enemy aircraft do not know the code, they cannot reply.

The enemy may, of course, try to jam the AWACS radar by using electronic counter-measures (known as ECM). The USAF has naturally thought of this trick and the radar

**The cut-away drawing shows a Boeing 707 airliner converted for US Air Force AWACS use. Where the passengers would normally sit are banks of communications consoles—an airborne control centre**







incorporates electronic counter-counter measures (ECCM) to filter out the jamming signal!

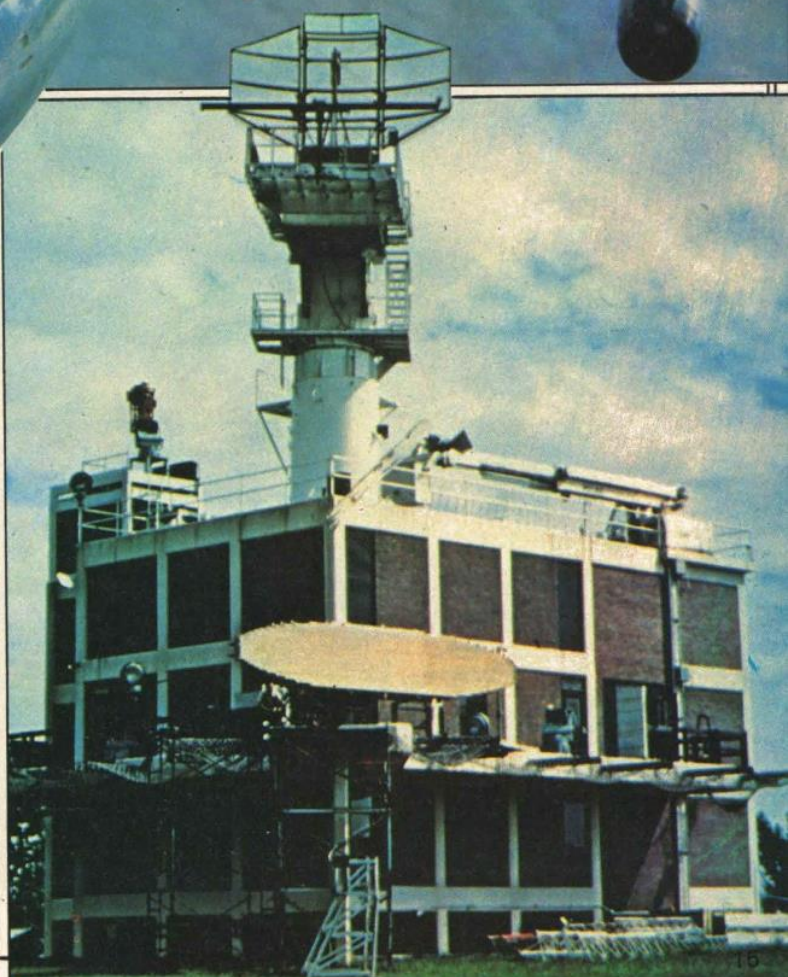
AWACS will probably rely on friendly fighters for its own defence. Nevertheless the USAF is making a study of ways in which it can carry its own battery of defensive missiles.

When being used for the defence of the United States, the E-3A will direct the F-15 Eagle air superiority fighters, the F-106 Delta Dart and possibly one of the new lightweight fighters, the YF-16 and YF-17, if they enter squadron service.

If the American Government agrees, the USAF will buy 34 E-3As at the staggering cost of 2,500 million dollars, (over £1,000 million). This is similar to the total amount of money spent so far by Britain and France on the Concorde supersonic airliner, and more than the total estimated cost of the Channel Tunnel!

Although AWACS is first and foremost a military system, Boeing says that it could be used for a number of civil duties. The company suggests that an E-3A could be stationed over the mid-Atlantic to assist with air traffic control. The AWACS radar could be used to warn of, and to track, the approach of tornadoes while its communications system could be used as a flying nerve centre to direct relief operations following a natural disaster like a flood or earthquake.

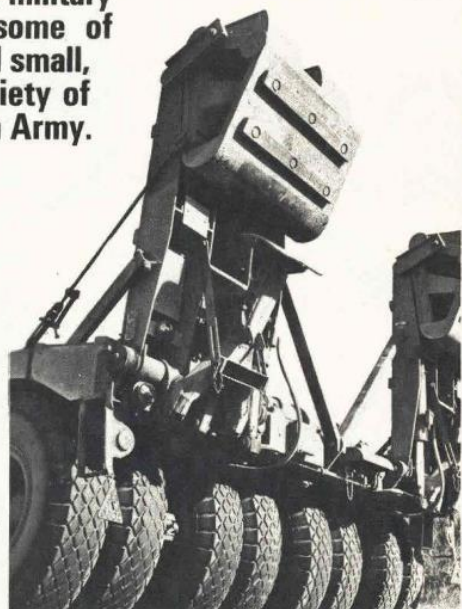
**Above, left: The radar antenna (called Brassboard) shown on a test range. In use, it is fitted in the Rotodome above the aircraft and it receives signals from a transmitter in the 707's fuselage. Signals from friendly airplanes are in code, and to guard against "jamming" by the enemy the radar system has built-in electronic counter-countermeasures (ECCM). Above: one of two US Air Force converted Boeing 707s, during test flights to decide which radar equipment to use in the AWACS system. Two American companies supplied radar equipment and the US Air Force had a "fly-off" competition between the two 707s. Right: the Brassboard radar antenna fitted for tests to a communications building (about half-way up).**





# ARMY ON WHEELS

In the last part of our series about military vehicles we take a look at some of the oddities, both large and small, which carry out a variety of roles in the British Army.



Left: A Chieftain tank being unloaded from a tank transporter. Right: The rear of the transporter's 16 ton trailer sports a pair of huge hydraulically operated ramps and no less than eight sets of dual wheels.

To carry a 51 ton Chieftain tank to a battlefield you need a very substantial truck and trailer. The Army uses an Antar truck and trailer unit (right) which, when loaded, has an all-up weight of 100 tons. A huge turbocharged 16-litre engine powers the transporter. Below, left: A Shorland armoured patrol vehicle based on the chassis of a Land Rover. The armoured body provides protection against small arms fire for the three-man crew, the engine and the fuel tanks. Protective flaps can be dropped down over the windscreen, and observation and escape hatches are provided in the turret at the rear. The turret is turned or traversed by hand and can be armed with a .30 Browning or 7.62 General Purpose machine gun. The Shorland has a top speed of 50mph and a range of about 200 miles. Below, right: Amphibious DUKWs or "Ducks" of the 17 Port Regiment, at St. Helier, Jersey. These six-wheeled vehicles were built in large numbers during World War II to carry troops and cargo in ship-to-shore operations. Based on a truck chassis, the DUKW has the unusual ability of being able to alter its tyre pressures while on the move to suit the terrain it is crossing.



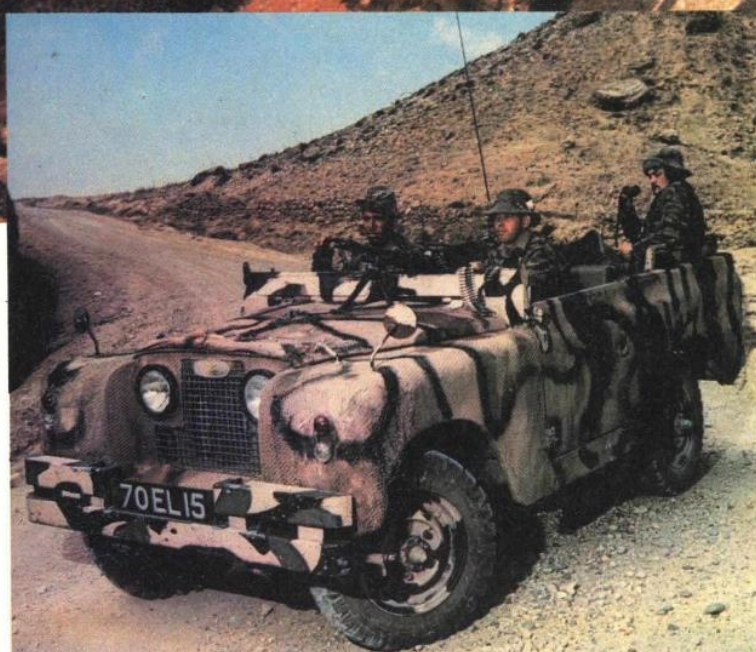




*Photos: courtesy of  
Ministry of Defence*

Like a gigantic insect with huge feelers, this Chieftain bridge layer extends its 80-foot-long jointed span to bridge a gulley so armoured vehicles and other tanks can cross. A large hydraulic ram on the 50 ton unit can extend the span in about two minutes and fold it back over the chassis in three minutes. Below, left: A Land Rover on patrol in Cyprus. It is "wearing" desert camouflage and is armed

with two machine guns. Below, right: An 11-ton wheel loader of the Royal Engineers (Airfields) helps with a "parking" problem in a rather drastic way. Fortunately the owner of the car had decided to scrap it anyway! The loader is powered by a six cylinder diesel engine and is used for clearing land to make battlefield landing strips for aircraft.



*Photo: courtesy of SOLDIER;  
British Army magazine*



*Astronaut Howard Falcon's descent into the mysterious depths of the Jovian atmosphere had showed him there was a life form on the planet, but what form did it take?*

WHEN the true dawn finally arrived, it brought a sudden change of weather. *Kon-Tiki* was moving through a blizzard; waxen snowflakes were falling so quickly that visibility was reduced to zero. Falcon began to worry about the weight that might be accumulating on the envelope. Then he noticed that any flakes settling outside the windows quickly disappeared; *Kon-Tiki's* continual outpouring of heat was evaporating them as swiftly as they arrived.

If he had been ballooning on Earth, he would also have worried about the possibility of collision. At least that was no danger here; any Jovian mountains were several hundred miles below him. And as for the floating islands of foam, hitting them would probably be like ploughing into slightly hardened soap bubbles.

Nevertheless, he switched on the horizontal radar, which until now had been completely useless; only the vertical beam, giving his distance from the invisible surface, had thus far been of any value. Then he had another surprise.

Scattered across a huge sector of the sky ahead were dozens of large and brilliant echoes. They were completely isolated from one another and apparently hung unsupported in space. Falcon remembered a phrase—the earliest aviators had used to describe one of the hazards of their profession: 'clouds stuffed with rocks'. That was a perfect description of what seemed to lie in the track of *Kon-Tiki*.

It was a disconcerting sight; then Falcon again reminded himself that nothing really solid could possibly hover in this atmosphere. Perhaps it was some strange meteorological phenomenon. In any case, the nearest echo was about a hundred and twenty-five miles.

He reported to Mission Control,

which could provide no explanation. But it gave the welcome news that he would be clear of the blizzard in another thirty minutes.

It did not warn him, however, of the violent cross-wind that abruptly grabbed *Kon-Tiki* and swept it almost at right angles to its previous track. Falcon needed all his skill and the maximum use of what little control he had over his ungainly vehicle to prevent it from being capsized. Within minutes he was racing northward at over three hundred miles an hour. Then, as suddenly as it had started, the turbulence ceased; he was still moving at high speed, but in smooth air. He wondered if he had been caught in the Jovian equivalent of a jet stream.

The snow storm dissolved; and he saw what Jupiter had been preparing for him.

*Kon-Tiki* had entered the funnel of a gigantic whirlpool, some six hundred miles across. The balloon was being swept along a curving wall of cloud. Overhead, the sun was shining in a clear sky, but far beneath, this great hole in the atmosphere drilled down to unknown depths until it reached a misty floor where lightning flickered almost continuously.

Though the vessel was being dragged downward so slowly that it was in no immediate danger, Falcon increased the flow of heat into the envelope until *Kon-Tiki* hovered at a constant altitude. Not until then did he abandon the fantastic spectacle outside and consider again the problem of the radar.

The nearest echo was now only about twenty-five miles away. All of them, he quickly realized, were distributed along the wall of the vortex, and were moving with it, apparently caught in the whirlpool like *Kon-Tiki* itself. He aimed the telescope along the radar bearing and found himself looking at a curious mottled cloud that almost filled the field of view.

It was not easy to see, being only a little darker than the whirling wall of mist that formed its background. Not until he had been staring for several minutes did Falcon realize that he had met it once before.

The first time it had been crawling across the drifting mountains of foam, and he had mistaken it for a giant, many-trunked tree. Now at last he could appreciate its real size and complexity and could give it a better name to fix its image in his mind. It did not resemble a tree at all, but a



Like a squadron of fighters, the giant mantas swooped down to attack the Medusa.

jellyfish—a medusa, such as might be met trailing its tentacles as it drifted along the eddies of the Gulf Stream.

This medusa was more than a mile across and its scores of dangling tentacles were hundreds of feet long. They swayed slowly back and forth in perfect unison, taking more than a minute for each complete undulation—almost as if the creature was clumsily rowing itself through the sky.

## MILLION TONS

The other echoes were more distant medusae. Falcon focused the telescope on half a dozen and could see no variations in shape or size. They all seemed to be of the same species, and he wondered just why they were drifting lazily around in this six-hundred-mile orbit. Perhaps they were feeding upon the aerial plankton sucked in by the whirlpool, as *Kon-Tiki* itself had been.

'Do you realize, Howard,' said Dr. Brenner, when he had recovered from his initial astonishment, 'that this thing is about a hundred thousand times as large as the biggest whale? And even if it's only a gasbag, it must still weigh a million tons! I can't even guess at its metabolism. It must generate megawatts of heat to maintain its buoyancy.'

'But if it's just a gasbag, why is it

such a damn good radar reflector?'

'I haven't the faintest idea. Can you get any closer?'

Brenner's question was not an idle one. If he changed altitude to take advantage of the differing wind velocities, Falcon could approach the medusa as closely as he wished. At the moment, however, he preferred his present twenty-five miles and said so, firmly.

'I see what you mean,' Brenner answered, a little reluctantly. 'Let's stay where we are for the present.' That 'we' gave Falcon a certain wry amusement; an extra sixty thousand miles made a considerable difference in one's point of view.

For the next two hours *Kon-Tiki* drifted uneventfully in the gyre of the great whirlpool, while Falcon experimented with filters and camera contrast trying to get a clear view of the medusa. He began to wonder if its elusive colouration was some kind of camouflage; perhaps, like many animals of Earth, it was trying to lose itself against its background. That was a trick used by both hunters and hunted.

In which category was the medusa? That was a question he could hardly expect to have answered in the short time that was left to him. Yet just before noon, without the slightest warning, the answer came...

Like a squadron of antique jet

fighters, five mantas came sweeping through the wall of mist that formed the funnel of the vortex. They were flying in a V formation directly towards the pallid grey cloud of the medusa; and there was no doubt, in Falcon's mind, that they were on the attack. He had been quite wrong to assume that they were harmless vegetarians.

Yet everything happened at such a leisurely pace that it was like watching a slow-motion film. The mantas undulated along at perhaps thirty miles an hour; it seemed ages before they reached the medusa, which continued to paddle imperturbably along at an even slower speed. Huge though they were, the mantas looked tiny beside the monster they were approaching. When they flapped down on its back, they appeared about as large as birds landing on a whale.

Could the medusa defend itself, Falcon wondered. He did not see how the attacking mantas could be in danger as long as they avoided those huge clumsy tentacles. And perhaps their host was not even aware of them: they could be insignificant parasites, tolerated as are fleas upon a dog.

But now it was obvious that the medusa was in distress. With agonizing slowness, it began to tip over like a capsizing ship. After ten minutes it had tilted forty-five degrees. It was also rapidly losing altitude. It was im-

KEY TO JUPITER  
Part 4  
G. Clarke

# MEETING WITH MEDUSA



possible not to feel a sense of pity for the beleaguered monster, and to Falcon the sight brought bitter memories. In a grotesque way, the fall of the medusa was almost a parody of the dying *Queen's* last moments.

Yet he knew that his sympathies were on the wrong side. High intelligence could develop only among predators—not among the drifting browsers of either sea or air. The mantas were far closer to him than was this monstrous bag of gas. And anyway, who could *really* sympathize with a creature a hundred thousand times larger than a whale?

Then he noticed that the medusa's tactics seemed to be having some effect. The mantas had been disturbed by its slow roll and were flapping heavily away from its back—like gorged vultures interrupted at mealtime. But they did not move very far, continuing to hover a few yards from the still-capsizing monster.

There was a sudden, blinding flash of light synchronized with a crash of static over the radio. One of the mantas, slowly twisting end over end, was plummeting straight downward. As it fell, a plume of black smoke trailed behind it. The resemblance to an aircraft going down in flames was quite uncanny.

In unison, the remaining mantas dived steeply away from the medusa, gaining speed by losing altitude. They had, within minutes, vanished back into the wall of cloud from which they had emerged. And the medusa, no longer falling, began to roll back towards the horizontal. Soon it was sailing along once more on an even keel, as if nothing had happened.

'Beautiful!' said Dr. Brenner, after a moment of stunned silence. 'It's developed electric defences, like some of our eels and rays. But that must have been about a million volts! Can you see any organs that might produce the discharge? Anything looking like electrodes?'

'No,' Falcon answered, after switching to the highest power of the telescope. 'But here's something odd. Do you see this pattern? Check back on the earlier images. I'm sure it wasn't there before.'

A broad, mottled band had appeared along the side of the medusa. It formed a startlingly regular checkerboard, each square of which was itself speckled in a complex sub-pattern of short horizontal lines. They were spaced at equal distances in a geometrically perfect array of rows and columns.

'You're right,' said Dr. Brenner, with something very much like awe in his voice. 'That's just appeared. And I'm afraid to tell you what I think it is.'

'Well, I have no reputation to lose—at least as a biologist. Shall I give my guess?'



One of the mantas spiralled away from the Medusa trailing a plume of smoke. Its resemblance to an aircraft was uncanny.

'Go ahead.'

'That's a large meter-band radio array. The sort of thing they used back at the beginning of the twentieth century.'

'I was afraid you'd say that. Now we know why it gave such a massive echo.'

'But why has it just appeared?'

'Probably an after effect of the discharge.'

'I've just had another thought,' said Falcon, rather slowly. 'Do you suppose it's *listening* to us?'

'On this frequency? I doubt it. Those are meter—no, *decimeter* antennas—judging by their size. Hmm . . . that's an idea!'

Dr. Brenner fell silent, obviously contemplating some new line of thought. Presently he continued: 'I bet they're tuned to the radio outbursts! That's something nature never got around to doing on Earth. . . . We have animals with sonar and even electric sense, but nothing ever developed a radio sense. Why bother where there was so much light?'

'But it's different here. Jupiter is drenched with radio energy. It's worth while using it—maybe even tapping it.

That thing could be a floating power plant!'

A new voice cut into the conversation.

'Mission Commander here. This is all very interesting, but there's a much more important matter to settle. *Is it intelligent?* If so, we've got to consider the First Contact directives.'

'Until I came here,' said Dr. Brenner, somewhat ruefully, 'I would have sworn that anything that could make a shortwave antenna system must be intelligent. Now, I'm not sure. This could have evolved naturally. I suppose it's no more fantastic than the human eye.'

'Then we have to play safe and assume intelligence. For the present, therefore, this expedition comes under all the clauses of the Prime directive.'

There was a long silence while everyone on the radio circuit absorbed the implications of this. For the first time in the history of space flight, the rules that had been established through more than a century of argument might have to be applied. Man had—it was hoped—profited from his mistakes on Earth. Not only moral considerations, but also his own self-interest demanded that

he should not repeat them among the planets. It could be disastrous to treat a superior intelligence as the American settlers had treated the Indians, or as almost everyone had treated the Africans. . . .

The first rule was: keep your distance. Make no attempt to approach, or even to communicate, until 'they' have had plenty of time to study you. Exactly what was meant by 'plenty of time', no one had ever been able to decide. It was left to the discretion of the man on the spot.

A responsibility of which he had never dreamed and descended upon Howard Falcon. In the few hours that remained to him on Jupiter, he might become the first ambassador of the human race.

And *that* was an irony so delicious that he almost wished the surgeons had restored to him the power of laughter.

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**Next week:  
Prime Directive.**

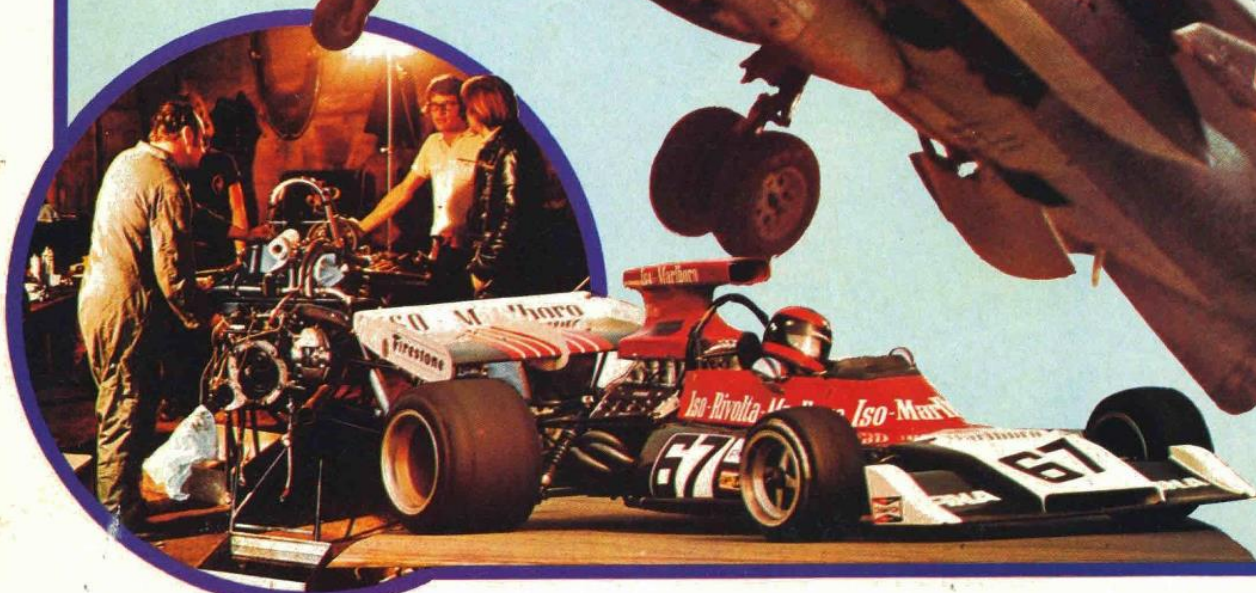


# Speed & Power

10p Weekly No. 12 June 7-14, 1974

**Harrier Nerve Centre  
Men Behind Racing**

**Planes Cars Ships Trains  
Science Fiction**





Mine and quarry work is big business anywhere in the world. In the USA, the vast distances between working sites, coupled with the size of the mines and quarries themselves, all adds up to a problem of getting the men to move rock and other materials. The solution is to use big machines. Here, we look at two of them—a huge dump truck and a rock shovel loader.

EVERYONE knows that all things are big in Texas (according to the Texans, at least). However, we doubt if even they expected to produce anything like the V-Con 3006 end dump truck.

Tough, mighty tough, is an understatement for this quarry worker, since it weighs 350,000lb, and takes up a payload of 250 tons. The average dump truck you might see working in Britain can carry perhaps 15 tons.

The V-Con requires a diesel

engine of 3,000hp to move the vehicle, which is a massive 43ft. long, 28ft. wide and has a loading height of no less than 21ft.

At present the machine is the largest truck in the world although, incredibly, the manufacturers are already talking of an even bigger one—a 400 ton version! The V-Con makers, Peerless Manufacturing Co., say the limit of truck size has certainly not yet been reached.

Naturally, such a machine as the 3006 truck needs a special design

to maintain its stability when travelling. There are eight single, independent tyre mounts, and length of tyre life is aided by the suspension, which includes a dampening system. Liquid spring suspension gives a softer spring rate than the tyres.

Any irregularities in the road surface are taken care of by further special design features, such as independently sprung oscillating wheel pairs. These allow individual tyres to take up their share of the total vehicle weight on any road conditions. Six of the wheels are electrically motorised, which means they will operate, even loaded, on gradients.

Engine cranking, batteries supply full steering and braking power should the engine be dead, while the brakes are electronically-actuated hydraulic units.

Understandably, there are other safety devices. Split steering and braking systems cut the chances of losing more than half of either system at any one time. In fact, the vehicle's builders say that the truck can be safely used for long periods with half the steering hydraulics out of action.

Driving the truck is quite an experience. Perched high up on the front left side of the vehicle, the driver gets an excellent view to front, rear and side. With a vehicle of such size, the view to the rear is most important when reversing!

Servicing the machine is no problem. All parts likely to need regular maintenance are located where they can be reached easily. Single mounting of the tyres means that, should an inside tyre in a dual

pair blow out, it is not necessary to remove the good tyre to get at it.

As round-the-clock working is common in the quarries where the truck would be found, special attention has been paid to the vehicle's lighting system. For improved night visibility the headlights turn to the direction in which the front wheels are pointed, so that maximum light is always where it is needed.

To gain some idea of a typical job on which the truck would be seen, take the example of its use on quarry work.

The dump truck is required to load up, travel 13,500 feet, turn, dump its load and return. Payload on this occasion is 230 ton and the truck makes just over two trips every hour, burning up fuel at the rate of 60 gallons an hour! Diesel fuel, remember, is much cheaper than your car's petrol.

The cost of operating a machine like the 3006 truck sounds high, but its enormous payload, plus the fact that only one man is needed to operate it, mean that the owner of the vehicle soon gets his money back.

Obviously, such machines would only be found working in the wide open spaces of countries such as America. They come into their own in mines and quarries located far from civilisation, where manpower is expensive and hard to find.

# MIGHTY EARTH MOVER

Another machine which uses its weight when pushing things around in a big way on American construction and quarry sites is the Michigan 675 articulated rock shovel, made by the Clark Equipment Co. It is 41ft. 7in. long and 33ft. 7in. wide, and can turn in a mere 42ft. radius.

The buckets fitted on the front of the machine are 16ft. 8in. wide and can scoop up a load to give a heaped capacity of 24 cubic yards. Four massive, water ballasted tyres support the machine which can travel in forward and reverse at speeds ranging from 3½mph up to 17½mph in top—which is fast with a load of up to 186,000lb!

Four-wheel power hydraulic disc brakes bring this giant among loading shovels to a stop.

Two engines are necessary to propel the machine and its load, and they are diesels giving a maximum horsepower of 635. There are 16 cylinders and a fuel tank capacity of 500 gallons, while the electrical system is 24

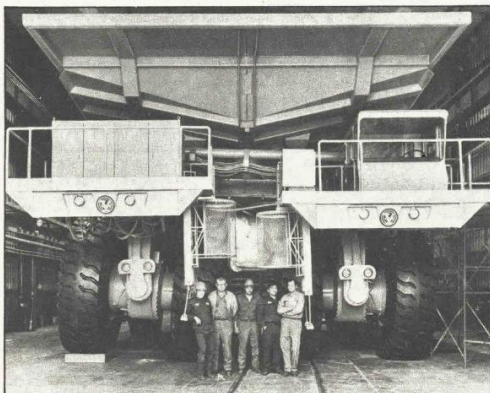
volts. All-wheel drive axles are fitted. The rear axle moves, like a pendulum, up to 20 degrees.

Although the loader is designed to work in rough, tough conditions, that does not mean that the driver has to put up with an uncomfortable ride. In fact, the comfort provided on modern machines of this type is almost as good as that found in the family car.

Thus, in the 675 loader, there is an adjustable air-cushioned bucket seat, wintensation kit, enclosed pressurised cab, windshield wipers front and back, automatic back-up alarm system, air conditioner and cigar lighter.

Gauges on the dashboard cover just about every function of the machine, and it is even possible to have installed a mercury vapour lighting system.

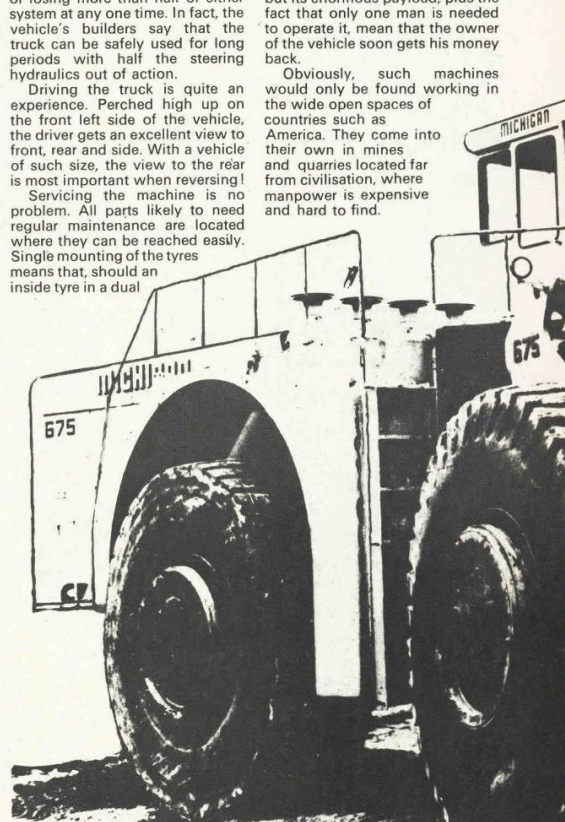
So it is a combination of comfort and massive power that is winning America's battle to extract from her quarries the vital materials necessary for the industrial life of the nation.



Above: Towering over men beneath it, the V-Con 3006 dumper.



Above and right: The mighty and powerful Michican 675 loader.



V-Con dump truck:  
the facts  
**Overall dimensions:**  
Length, 43ft. Width,  
28ft., height, 21ft.  
Wheelbase, 25ft.  
Ground clearance, 3ft.  
**Engine:** 3,000hp  
four-cycle  
turbocharged diesel.  
**Payload:** 250 tons.  
**Steering:** Hydraulic;  
turning radius, 51ft.  
**Suspension:** liquid  
type.  
**Brakes:** On powered  
wheels, disc with  
service and parking  
callipers; on  
unpowered wheels,  
internal expended  
drum.



Rear of the V-Con 3006, showing the massive wheels.



Britain's latest  
submarines are like

# Underwater Cruisers

FROM THE graceful wooden walls of the sail era, the task of the Royal Navy's capital ships has remained the same—deter or destroy!

Only the shape has changed. Instead of huge battleships, the new peacekeepers are the sleek, menacing, 7,000-ton underwater cruisers—the nuclear powered Polaris submarines. No place on Earth is outside the range of their 16 A.3 missiles with nuclear warheads. The furthest point in the world from the sea is near Lake Baikal in Central Asia, 1,720 miles inland. Each missile has a range of 2,500 miles with an accuracy measured in yards.

The building of the Four R's—Revenge, Repulse, Resolution, Renown—was one of the greatest enterprises ever undertaken by the Royal Navy. Over 800 firms were involved. It was planned in 1963 that the first missile would be fired down the Cape Kennedy range in America on 15 February, 1968. The 31-foot long missile shook the water from its tail and rose gleaming in the sky—15 thousandths of a second late!

As the missile roars out of the ocean, internal computers control the powered flight and, exactly on time, the guidance system triggers separation and the missile glides away to the target.

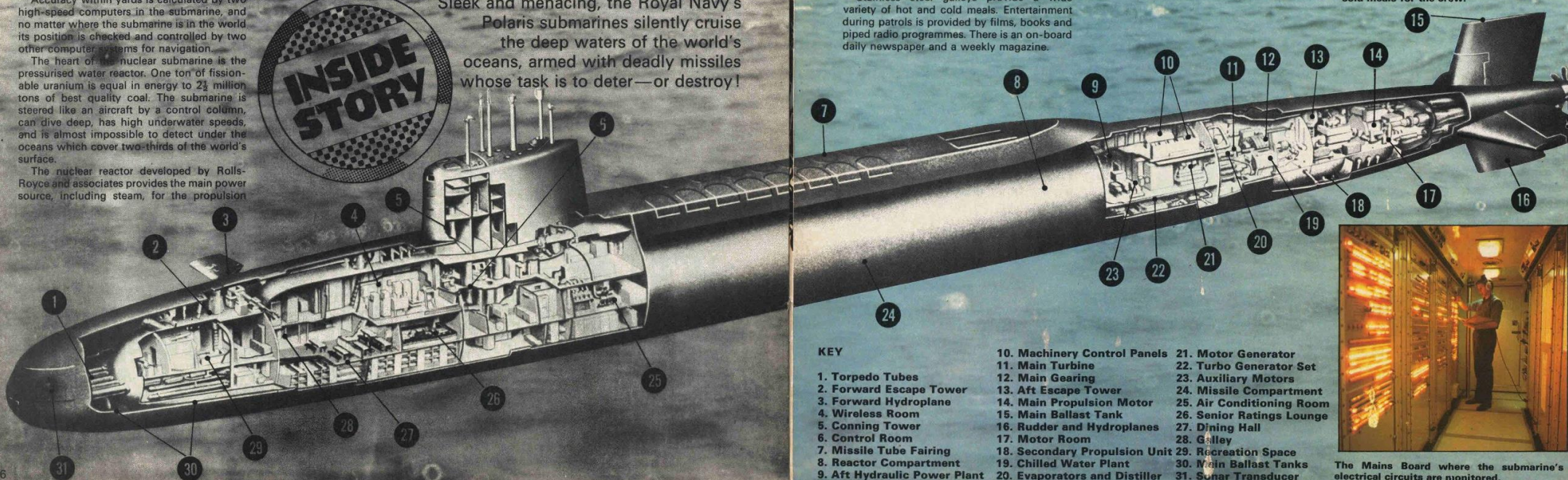
Accuracy within yards is calculated by two high-speed computers in the submarine, and no matter where the submarine is in the world, its position is checked and controlled by two other computer systems for navigation.

The heart of the nuclear submarine is the pressurised water reactor. One ton of fissionable uranium is equal in energy to 2½ million tons of best quality coal. The submarine is steered like an aircraft by a control column, can dive deep, has high underwater speeds, and is almost impossible to detect under the oceans which cover two-thirds of the world's surface.

The nuclear reactor developed by Rolls-Royce and associates provides the main power source, including steam, for the propulsion

Sleek and menacing, the Royal Navy's Polaris submarines silently cruise the deep waters of the world's oceans, armed with deadly missiles whose task is to deter—or destroy!

INSIDE STORY



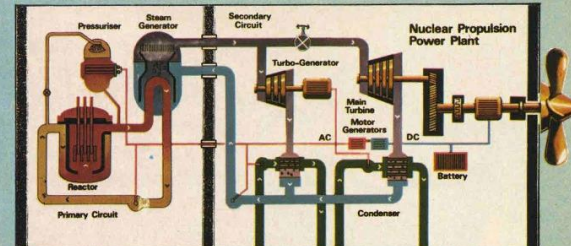
Polaris submarine HMS Resolution with the Captain at the periscope.

turbines and turbo-generators. This power source does not breathe air and in the normal sense, does away with the need to refuel over long periods of time. Yet the fission material could be compressed into a small pot.

Oxygen is taken from the sea water and pure air circulated by air conditioning machinery. Distillers provide some 5,000 gallons of fresh water a day. There is an efficient refrigeration plant. Dust and carbon monoxide is removed from the air.

All this is packed within a giant submarine with three decks which each draw nearly as much water as the liner QE 2!

Stainless steel galleys provide a wide variety of hot and cold meals. Entertainment during patrols is provided by films, books and piped radio programmes. There is an on-board daily newspaper and a weekly magazine.



Water heated by the nuclear reactor turns to steam and drives the main turbines.

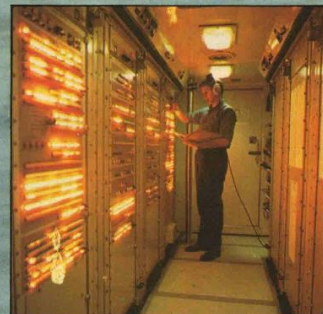


The galley provides a wide variety of hot and cold meals for the crew.

## KEY

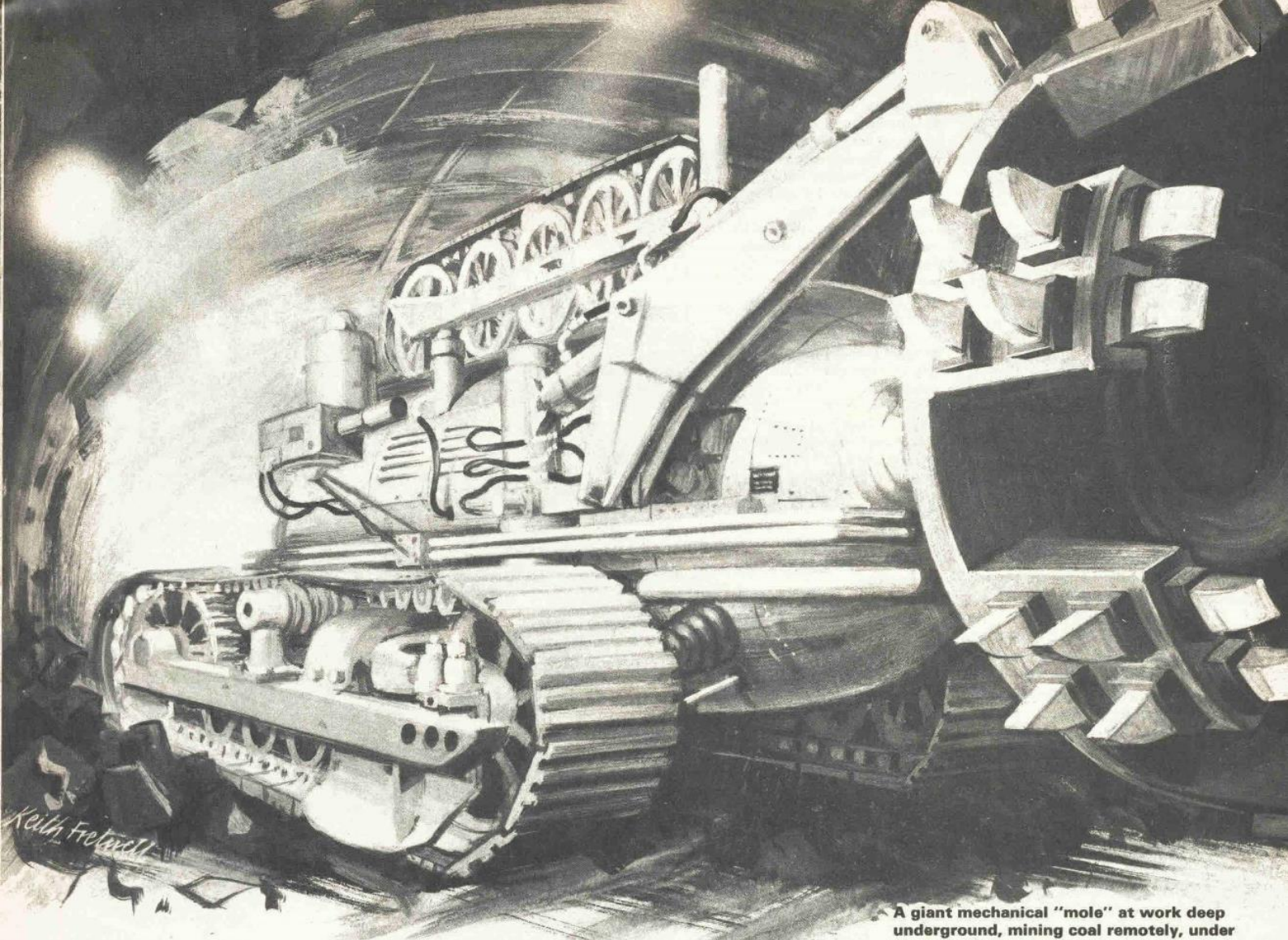
1. Torpedo Tubes
2. Forward Escape Tower
3. Forward Hydroplane
4. Wireless Room
5. Conning Tower
6. Control Room
7. Missile Tube Fairing
8. Reactor Compartment
9. Aft Hydraulic Power Plant

10. Machinery Control Panels
11. Main Turbine
12. Main Gearing
13. Aft Escape Tower
14. Main Propulsion Motor
15. Main Ballast Tank
16. Rudder and Hydroplanes
17. Motor Room
18. Secondary Propulsion Unit
19. Chilled Water Plant
20. Evaporators and Distiller
21. Motor Generator
22. Turbo Generator Set
23. Auxiliary Motors
24. Missile Compartment
25. Air Conditioning Room
26. Senior Ratings Lounge
27. Dining Hall
28. Galley
29. Recreation Space
30. Main Ballast Tanks
31. Sonar Transducer



The Mains Board where the submarine's electrical circuits are monitored.





A giant mechanical "mole" at work deep underground, mining coal remotely, under the control of men on the surface.

# MOLE MINER

**Britain's increasing need for energy means we will have to extract more coal from our mines, faster. Here, Professor M. W. THRING, of Queen Mary College, London, describes his solution, and a *SPEED & POWER* artists puts it into action.**

**M**INING is a tough job! Digging for coal is difficult, tiring, and can be dangerous at times. Men work in cold, damp, unnatural conditions hundreds of feet below the surface, hacking away coal which keeps our homes, offices and factories warm and well-lit.

Finding enough men to go down to work in the murk and mire of Britain's mines will always be hard, in spite of the National Coal Board's progressive training and apprenticeship schemes. This could mean that excellent coal may be wasted unless we can find a way of winning it without men having to go underground. That is, winning it in much the same way that we obtain oil—by drilling holes and pumping it up.

There are many seams of coal in Britain which are so thin that men could never squeeze in to work them, and yet sometimes they produce the finest coal in the country.

These seams are only about a

foot or a foot and a half thick. There are other seams which contain so many bands of dirt mixed with the coal that it is not worth mining, but if we can develop a machine which would separate the coal from the dirt *down there* and leave the dirt behind, we could then win coal and help to reduce the subsidence on the surface.

Subsidence at present causes railway lines in mining areas to move down by sometimes as much as four feet, and damages buildings on the surface.

There are other seams in Britain sloping so steeply that they would be impossibly dangerous for men to work, and some far under the North Sea where it would be difficult for men to travel to and from daily.

But, the Russians have already controlled from Earth a robot which could take samples of the Moon's surface, and there is no reason whatever why we should

**CONTINUED ON NEXT PAGE**



not develop machines which can be controlled from the surface to dig out coal and bring it up from deep mines.

There are two ways in which this could be done. The first is more like drilling for oil and would leave about half the coal underground unused. This method is particularly suitable for the very narrow seams and steep sloping seams, but not for the seams with bands of shale enclosed in them.

In this method a self-propelling drill, with its own motor and method of forcing itself through the ground and its own system of steering itself round corners, would be controlled from the surface. As in drilling for oil the machine would be fed with water, and bring up the material to the surface in the return flow of mud.

It would consist of two parts—a front and rear joined by three hydraulic rams. The front part would carry the drilling head.

The machine would have to be fed with control signals from the surface and have its own prime mover, perhaps in the form of a liquid fuel and air system going down in pipes to operate a high-power internal combustion engine.

## SENSING HEADS

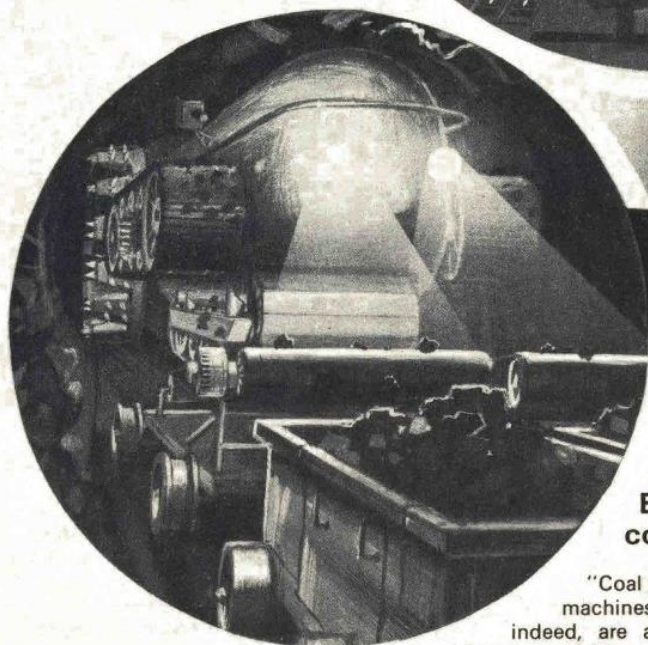
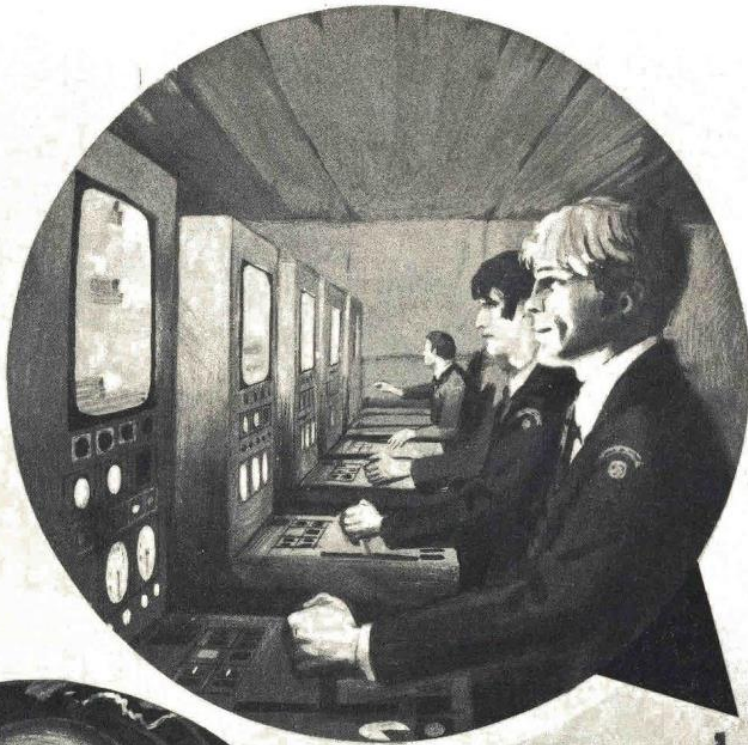
The most important point is that it would have to have sensing heads on the front of the cutting part so that it could detect the edge of the coal seam and be steered to remain in the seam. This machine would be operated to drive a series of parallel holes through the seam situated just far enough apart so that the surface did not collapse when the coal was removed.

The second machine would operate similarly to the present "long wall" system of mining. This would require a number of machines to do the same processes as at present; that is, propping the face, cutting roadways, shearing the coal and feeding the coal to the surface.

The most important machine that has to be developed for this system is one which would be able to carry out repairs to the other machines or control the others, while itself being controlled by a man on the surface.

The operator sitting in the surface control cabin would have a television screen showing the machine below ground, and two control "gloves". Through these he could operate the machine to go where there was a breakdown, inspect the damage or fault with the television camera, and then

**Right: Miners of tomorrow? In the comparative luxury of a surface control room, men control their mole miners with the aid of closed circuit TV and control levers. Men would only rarely have to venture down the mines—remote control machines could even carry out repairs on the mining vehicle. Below: Able to work at peak output almost non-stop, the mining machines could do virtually every job. Men wouldn't even have to touch the coal! Here coal is poured into trucks ready to be transported to the surface after being fed by conveyor from the coal face.**



## A National Coal Board spokesman comments:

"Coal mines of the future will have many of the machines envisaged by Professor Thring: some, indeed, are already in use. We have gamma ray detectors to differentiate between coal and rock, effectively guiding the mining machines in the coal seams. We use closed circuit television for a great number of remote monitoring and control operations; belt conveyors are the main system for carrying coal underground; and self-propelling mobile props are used on 80 per cent of our coalfaces. Two experimental coalfaces without a single man working on them have been tried in Midlands pits and from these experiments will come a wide range of remotely controlled mining machines which will help to make mining easier and safer. The real mine of tomorrow will be every bit as exciting as Professor Thring imagines—and we are working on it today."

carry out repairs using tools on the machine. The mechanical hands would follow the movements of his hands exactly as though he were down in the mine himself.

The machine would be propelled by a series of tracks above and below the main body, which would allow it to carry or drag heavy weights even up a vertical shaft.

## CONVEYOR BELTS

The other machines which would be necessary for this type of coal mining would be a series of sloping belt conveyors, each one separately driven so that each one could carry the coal and drop it on to the next one.

There would also have to be a

self-propelling mobile pit prop. This would support the long wall face down which the special coal cutting machine was operating. Another robot able to cut roadways and line them with reinforced concrete would be needed

so that a completely safe roadway was left behind it.

By the use of such machines it should be possible to do all the most sophisticated mining operations safely under control from the surface.



# **Speed** **& Power**

**10p Weekly**

**No. 13 June 14-21, 1974**



**Sky - Divers**

**Tornados on  
Two Wheels**

**Ships  
Cars Planes  
Science Fiction**





# Get-age Suggernauts

Driving giant lorries with heavy loads between Britain and the Common Market countries will be a job that calls for exceptional skills and equipment.

IN THE dark, on a crowded American highway, a small van with a puncture stopped suddenly, baulked a lorry, which in turn stopped a number of cars. Into this confusion of stationary vehicles came a 33 ton articulated lorry at 55mph, smashing, tragically killing seven people and starting fires. The driver may have been drowsy. No-one will ever know. Investigators said that he had plenty of time to assess the situation. They thought, too, that the brakes may not have been adequate and recommended "more extensive use of available technology".

This grim, true story illustrates three causes of concern about the design, management and driving of heavy vehicles on high-speed roads. The first concern is their increasing size. Thirty-two tons is the British limit, but it could one day go up to 40 or even 50 tons. Are they safe? Second, is enough use being made of the tremendously advanced equipment which is now available? Third, is the driver. Is he well trained and tested?

Answers to these questions already exist in air transport, and some are being adapted for road transport. For example, when airliners land, they are far bigger and faster than lorries, yet are safely stopped every day. Their brakes are adequate. A driver drowsing in his cab can be detected electronically and woken-up.

Drivers of heavy goods lorries may one day be trained and paid like some of today's airline pilots. Owners of big vehicles realise that it is no longer good enough to rely on experience alone. They must teach a driver to cope with all emergencies. His job can be more demanding than that of an airline pilot who, for long periods, may have very little to do. A lorry driver must always be ready for constant changes on his trip. In future his cab will have many aids to help him make every trip safely.

Already one British company, Smiths Industries Ltd., has prepared plans for a lorry cab layout which looks like a flight deck. All the vital information like speed, fuel, temperature will be on indicators raised to near eye level. The driver will see them without looking directly at them. He'll use what's called his "peripheral vision"—what the eyes can see apart from the object they are directly looking at. Another way of getting informa-

**Top:** A view through the windscreen showing the head-up display of the speedometer. The lower pictures show the warning lines on the screen telling the driver when he is too close to the vehicle ahead, and a futuristic dashboard showing a head-up display Stop warning.

Photos: Smiths Industries Ltd.



tion to the driver is to project it on to the windscreen. This system was developed for jet fighters to allow the pilot to scan ahead without looking down at the instruments. With a Head-Up Display, as it's known, speed, safe distance to drive behind the vehicle in front, warnings of malfunctions; and so on, can be seen without the driver taking his eyes off the road.

In his air-conditioned cab the driver of the future will, like an airline pilot, be controlling a gas turbine power unit. A great deal of work has been done on these relatively simple, compact engines.

All the instruments in the world will not help a driver in times of emergency. When the tractor unit of an articulated lorry gets pushed into a tyre-screaming, uncontrollable jack-knife, for example. It happens frequently. Too frequently for one man, ex-lorry driver, then fleet-owner, Mr. Fred Hope, who saw a way of preventing it by putting a disc brake on the kingpin. That's the 2½-inch-diameter pin on the semi-trailer which engages in a special slot on the tractor. He tried it out and to his delight it worked. Today, thousands of lorries are fitted and drivers' letters of thanks continually arrive at Mr. Hope's office.

Black ice on roads is an ever-present winter hazard. It is smooth, dangerous and cannot be seen easily. But ice can now be detected on the road hundreds of yards ahead by an airport safety device. This gives plenty of time for a driver to drop his speed and feel his way over it cautiously.

This business of feel or "driving by the seat of the pants" is still important. Drivers know instinctively when the vehicle is doing something unusual like sliding instead of rolling. But because of such improvements as power steering and longer vehicles with towed trailers, this old sense of feel is no longer reliable. For this reason the College of Aeronautics at Cranfield has been experimenting with ways of artificially creating "feel" for the driver.

It is particularly important with some loads especially liquids. Tankers negotiating roundabouts will sometimes turn over if the speed is too fast or even if the speed is too slow! And the results of a tanker overturning can be disastrous. In 1972 one person was killed and 20 injured by acid spilt from an overturned tanker on the M6, for example.

Other aids being developed to help drivers include tachographs which record speed and time in a way that gives a good deal of information about each trip and a driver's management of the lorry. An axle load indicator will show at a glance if the lorry is overloaded. Warnings from danger areas, which include the tyres, will be given when specific areas of the lorry become hot enough to

**Right: A British Leyland 400bhp gas turbine-engined tanker of 5,000 gallons capacity. Below: Some dangerous hills in Britain have beds of soft sand or shale at the bottom so that if all else fails, the driver of a lorry can run his vehicle into them.**



catch fire. Fires are more common than many suspect.

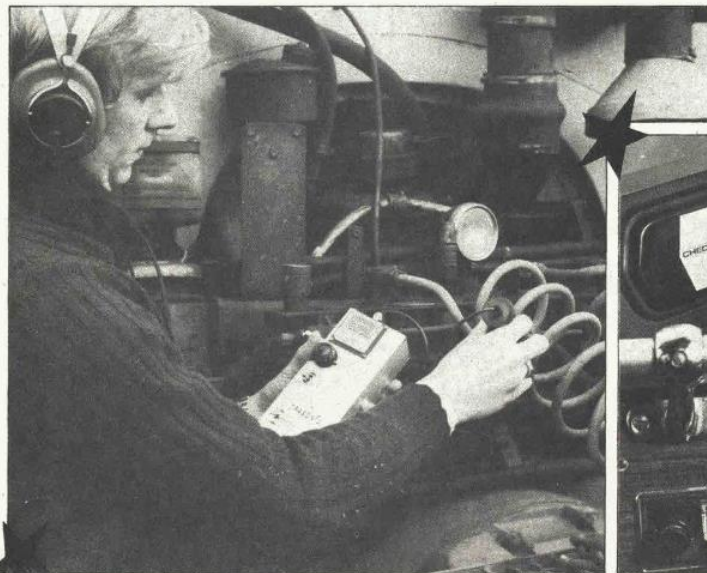
When the driver of a tractor hitches up to a semi-trailer at the dockside he has no way of knowing if its brakes are badly worn or in need of adjustment. A simple push-button indicator will give him instant answers to both questions. Now becoming essential is a simple indicator that tells a driver of a big lorry which of the 12 gears he's using.

How will a driver take it all in? First he will not be given instruments that require interpretation.

Like a thermometer that has to be read before deciding if it's too hot or too cold. Indicators will either command "Stop" for high bearing temperatures, for example, or "Switch" for lights in the evening. Or, they will indicate something that requires attention like shortage of fuel, or insufficient water. As to the rest, essential instruments will be kept to a minimum and placed where they can be seen easily. Instruments dealing with brake wear or load distribution will be looked at before the journey begins.

Just the same, with powerful new gas turbines, multi-ratio gear boxes; new handling techniques for longer and heavier vehicles and all the new instruments, it will soon be cheaper and safer to check-out drivers in an electronic simulator, like those used by airlines to test their pilots.

Future lorry drivers are going to need a lot of aids. Industry is already well advanced with solutions. But in the end those answers will be useless if lack of training means that a driver misreads or fails to read them at all.



**Left: Testing for air leaks in the braking system with a special detector. Below: A trailer brake wear indicator inside the driver's cab.**





# BIG MUSKIE

*Mechanical excavators are a common enough sight, being used for trench digging on housing estates and road construction. But it's doubtful that you have seen one like Big Muskie, America's walking dragline excavator used for digging coal. Big? If you live in a two-storey house, this machine's bucket could swallow up your home with room to spare!*

AMERICA has plenty of coal buried beneath the ground. It is estimated that there are 830 billion tons, enough to last the country for 1,500 years. The problem is that it lies buried in remote areas where conventional coal-mining is difficult.

So, Bucyrus-Erie of Milwaukee, USA, designed Big Muskie, the world's largest dragline excavator.

Taking an average English football pitch as being 345ft long, few clubs would welcome Big Muskie into their ground, since it measures 487ft. from end to end. Furthermore, the machine is wider than an eight-lane motorway plus central reservation. Try that for off-side! Obviously, such a machine is no lightweight and, in fact, this one weighs in at 27 million pounds. That is equal to 13,500 motorcars—a line of cars over 50 miles long. It is also more than the weight of 150 Boeing 727 jets!

At every bite, Big Muskie gobbles up 220 cubic yards of material (the most popular JCB type excavator seen at work in Britain takes up less than one cubic yard in its bucket). One single scoop by Big Muskie's bucket is enough to fill a column of 27 dumper trucks. In one action, the unit picks up 325 tons.

When the machine moves across the site it resembles something out of a science fiction story. The working base has a diameter of 105ft, and 14ft. steps are taken on four "walking shoes," each 65ft. long and 20ft. wide. Revolving the machine is carried out on 128 massive rollers.

Lifting materials is no problem for Big Muskie, either. It can hoist loads higher than a 30-storey building and dump them two city blocks away. Wire haulers are used for the operation of the bucket, and more than a mile of 5in. diameter wire rope is needed, passing through pulleys which are 15ft. in diameter.

Big Muskie is almost a mobile factory. In fact, the compartments housing the mechanism have their

own lighting and workshop. Electrical equipment on the machine produces enough power to supply nine-tenths of electrical needs of an American city such as Las Vegas or, if you prefer, to power 75,000 television sets.

If the dimensions so far mentioned have caused a few whistles, wait for the price—£94 million. That was what it cost to build Big Muskie for the Central Ohio Coal Co. Therefore, like running jet airliners, owning a machine of this type means being patient when it comes to making enough money out of it to cover your original investment.

To build such a machine presented the engineers with the need for new thinking on design, in addition to enlarging certain existing design principles.

Take these 5in. diameter wire ropes, for instance. Making them was enough of a problem, and handling them created fresh headaches, since one single hoisting wire rope on the machine weighs 25 tons. Yet, when the ropes are in position, they can be trusted to do their work well, because they have a breaking strength of 1,080 tons.

Big Muskie moves by means of a hydraulic walking system, which is basically a simple idea. There are four lifting cylinders, two for each "shoe" and four pushing cylinders on each "shoe."

The four lifting cylinders are held in the revolving frame and the pistons are connected to slides on the hinged "shoes" by ball joints. When the four lifting cylinders raise the machine the four pushing cylinders move it forward anything up to 14ft.

Since there are four points of lift, the walking mechanism lifts the base completely off the ground, thus cutting out sliding friction of the base on the ground. The total hydraulic walking system contains 26,000 gallons of oil.

A specially designed tubular boom is made up from two columns,

each 20ft. by 18ft. at the base, and each column is constructed from 24in. diameter tubes. Those tubes are pressurised with inert gas to help in the detection of cracks.

Assembling Big Muskie is a construction job in itself, requiring the skill of a team of engineering experts. Rail transport was used to ferry the component parts to the site. Over 30 segments, each weighing 50 to 80 tons, were used to make up the base of the machine, which has a diameter of 105ft.

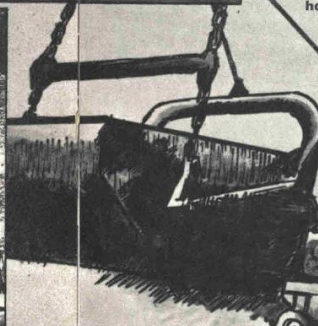
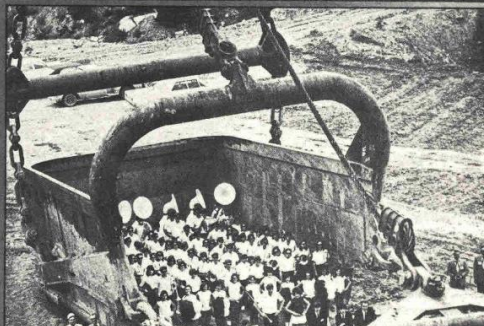
Segments were welded together and then machined into a unit at the site. The revolving frame section, also put together on the site, was made from 57 different parts.

At the mining site, electric power comes in at 69,000 volts and, after being metered, is stepped down to 13,800 volts by a transformer. Cable then carries power to the machine.

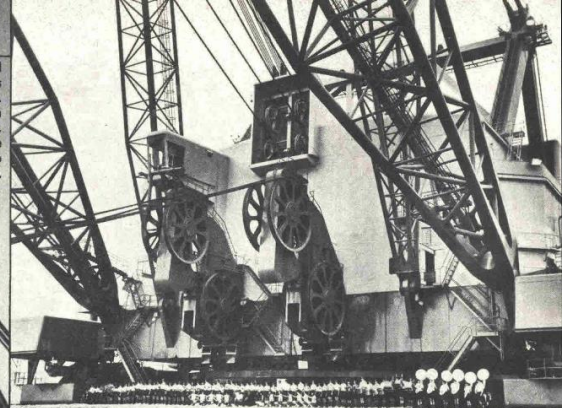
Even providing maintenance for Big Muskie is a major task. Special mobile cranes, designed to lift heavy parts, are used, one 40-ton and three 10-ton cranes being operated.

Each month the machine strips 41 million tons of surface material, and has replaced five major excavators. Amazingly, Big Muskie is operated by one man and an oiler, but they do need two-way radio to maintain contact with the rest of the site.

Right: A band is dwarfed by the giant machine's winding equipment. Below: Like a huge monster, Big Muskie swings into action.



Centre left: Big Muskie, the world's largest dragline excavator, in action. Bottom left: All aboard the big bucket! Muskie's scoop is large and hungry enough to devour a two-storey house!

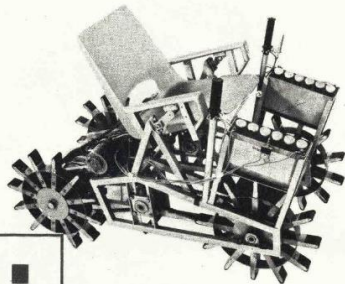


## FACTS AND FIGURES

|                     |                                              |
|---------------------|----------------------------------------------|
| Bucket capacity:—   | 220 cubic yards                              |
| Bucket dimensions:— | 20 ft. 8 in. by 25 ft. 2 in. by 13 ft. 5 in. |
| Weight              | 12053 tons                                   |
| Length              | 487 ft.                                      |
| Width               | 151 ft.                                      |
| Electric motors:    |                                              |
| Hoist               | 10 at 2,000 hp                               |
| Drag                | 8 at 2,000 hp                                |
| Swing               | 10 at 1,250 hp                               |
| Propel              | 24 at 600 hp                                 |
| Boom length         | 310 ft.                                      |
| Digging depth       | 185 ft.                                      |



# ROBOT RESCUER



Above: Professor Thring's experimental "walking chair" that can mount stairs.

*Fighting fires is a dangerous job and there are some places where even the bravest fireman dare not go, but in the future he may have a machine to help him.*

**F**IRE! Somewhere in a big town a building blazes. Flames and smoke pour from the windows, and a man is trapped on the top floor. Within minutes the fire brigade arrives; but the building is a raging inferno and no fireman could possibly brave the flames to reach the trapped person.

Out of the fire brigade vehicle comes a strange robot machine. It enters the burning building and scans the situation with a built-in TV camera. Sitting in safety outside is the controller, who views the scene projected by the robot on a screen. Acting upon what he sees, the controller directs the robot into the very heart of the fire, and triggers off hoses actually on the machine.

## A ROBOT KEEPS COOL

Though it is completely surrounded by flames, the robot suffers no ill-effect, for it is water-cooled. Within minutes this robot machine has the worst of the fire under control, and with its robot "eye" undertakes a systematic search of the building. It can even climb stairs, and soon the trapped man is found, though he is unconscious. By means

of special "arms," and directed by the controller, our robot "hero" carefully picks up the man and carries him to safety.

The story you have just read is fictitious; but in a few years time this could become an everyday account of how the fire brigades deal with dangerous fires.

## A HANDY MACHINE

There is a new branch of engineering called "Telechirics"—that is "hands at a distance." It is already used inside radioactive reactors, where people working outside can carry out delicate and skilled operations by means of remotely-controlled hands.

Also, a three-wheeled device which can carry a weight of a quarter of a ton up a staircase has been developed for the infirm. The wheels have no rims, but 12 sprung spokes on each wheel. Spokes bear on the level part of each step, and push the vehicle upwards. This could well be adapted for robot use.

Another piece of equipment which could form the basis of a "Telechiric" device is an army tank. Once remote control has been installed, the tank becomes a powerful and

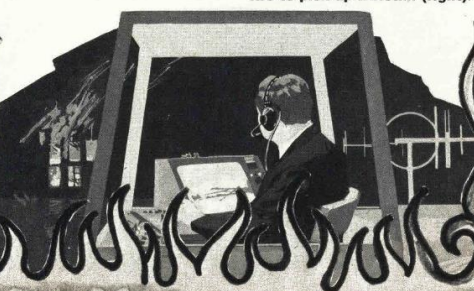
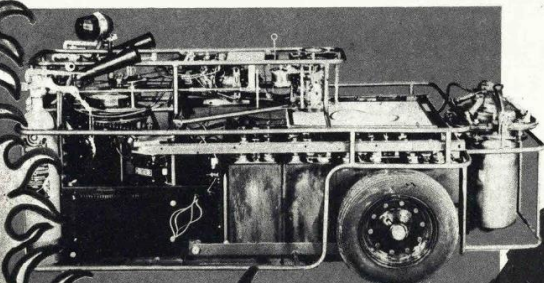
invincible robot like something out of science fiction. It could be used for such jobs as airport fire-fighting, and extinguishing giant fires at oilwells.

The advantages of these robot machines is that they can move right into the centre of fires and attack them at their source. At present, firemen and fire-fighting vehicles have to stand well away from fires and direct jets of foam into them. Because of this, much more foam is used than necessary, and it cannot always be directed to the seat of the fire. Sometimes this causes as much damage as the fire itself!

Most important of all, no lives would be at risk if a robot was used, and firemen would control fires in the comparative safety of the control console. Since fires cause millions of pounds worth of damage every year and many people lose their lives, the cost of equipping every fire brigade in the country would be small in relation.

It may not be long before fires are controlled by weird metal machines which can walk, climb, "see" and lift. Then these "robot rescuers" will help protect us against man's eternal enemy—fire.

Left: A prototype robot fire-fighter designed by Professor M. W. Thring of Queen Mary College, London. Below: How the controller would watch a robot rescuer's progress on a TV screen as it moved into the heart of the fire to pick up a victim (right).





A HUGE airliner comes to rest neatly, accurately with its nose almost touching the airport pier. It is 12 noon London Heathrow time. Within seconds, before the first passenger has left the cabin, a fleet of strange vehicles—many never seen outside an airport—begins to move towards the aircraft. It's an odd circus of transports each with a special job to do. Waddling at the head of this procession could be a tall flight of passenger steps. Then comes a mini-tanker carrying fresh water, followed by a big, specially soundproofed diesel generator to keep the aircraft lights burning and its electrical equipment running. Then vans with food, followed by strange flat transporters with rollers instead of a floor towing little trailers also with roller beds. Somewhere among the vehicles will be big tankers full of aviation kerosene fuel, lifting platforms to raise cargo and cars with long booms carrying rubber belts for moving luggage and small parcels.

Thirty minutes after the wheels of the first vehicle begin to roll towards the airliner, most of these strange transports will be away refuelling complete, food for perhaps 300 passengers on board, cabin cleaned, cargo and passenger luggage in the holds.

As the airport clock flicks to 12.30 a ground engineer waves "All clear" to the flight deck. The engines start. By a miracle of organisation the airliner is ready for another long non-stop flight. This time it may rumble in towards a runway over the Nile and the Pyramids, or across flares of burning waste gas from a Middle East oilfield.

Why the hurry? Airline accountants will say that a big airliner standing idle on the ground costs the

company something like £150 an hour or the staggering sum of £3,600 a day. The quicker it gets back into the air and earns money the better they like it.

All the strange vehicles help to make a quick turn-round between flights. Most of them are easy to spot. The big tanker might be one of the true giants filled with 18,000 gallons of kerosene or nearly four times the amount in the biggest tanker met on a road. The fuel gets into the aircraft tanks in a strange way too. Not through a hole on top of the wing but through a valve underneath. At the end of the tanker's hose is a special connector. In a one-half turn it locks firmly to the aircraft valve which the tanker pumps then forces open. Fuel fountains in at 1,000 gallons a minute. In fact, while filling a large kitchen saucepan—not

**CONTINUED  
ON NEXT  
PAGE**

# TOUGH~DOWN turn~around

It pays to get an airliner back into the air—fast! These odd transporters are just part of the airport scene





quite a gallon—from a household tap the tanker would pump 250 gallons!

There are two sorts of refuellers. One is the true tanker with its own supply of fuel. But for some big airliners the amount it carries may not be enough to fill the aircraft tanks after an Atlantic flight. So some airports, and Heathrow is one, have pipes under the concrete apron bringing kerosene from a huge storage area miles away. The second type of refueller, much smaller than the big tanker, has a huge reel of hose and connects one end to the "mains" and the other to the aircraft. These are called hydrant dispensers.

Clean fuel is very important. Water in it turns to ice crystals in the cold at 30,000 feet, blocks filters and may stop the jet engine. Dirt, too, collects on the filters and stops them working properly. Oil companies go to endless trouble to filter out water, and tiny particles of dirt less than 0.00004 inches in diameter, so small that you can hardly see them. It's hard to believe that anything would be able to live in a hostile home like refined kerosene but there is one tenacious slime that grows in any water in storage tanks and feeds on the fuel—this, too, has to be filtered out.

Another unusual but useful vehicle seen only on airports, loads and unloads containers or igloos into spaces under the cabin floor. When trundling across the apron these vehicles are close to the ground but at the touch of a lever the whole carrying platform is lifted up by hydraulic rams until it is level with the aircraft door. Rollers under the containers then quickly and cleanly propel them into the aircraft hold.

Many vehicles which raise and lower their working bodies are used at airports. This is be-

cause different aircraft have different door heights so that a fixed floor van which could be used on a Boeing 707 would be of little use on a jumbo Lockheed TriStar. The food carrying van commonly called a Commissary Truck, for example, looks very much like an ordinary van. But its whole body will lift up to 20 feet and a little bridge with a conveyor belt moves metal boxes with fresh food into the aircraft galley and takes out all the old boxes.

Pumping up tyres on a family car is easy compared with getting air into a big aircraft wheel. Air is also needed to start some jet engines. These jobs call for a mobile compressor but airlines are now trying a special gas maker that uses non-inflammable liquid nitrogen.

When all the special vehicles move away, their jobs finished, just one is left. It's job is to push the airliner backwards away from the airport pier. These tractors, specially designed for big jets, are very low on the ground so that they can drive under the jumbo's engines and under the aircraft belly without hitting it.

Final question on fast turn-round: could you empty 270 TriStar ashtrays in 30 minutes? It's quite a job. But the inventive Canadians have thought of one solution. They use a big suction cleaner that whooshes everything out, cigarette ends, paper, orange peel and all the bits that usually finish up in an ashtray. Their name for it? A Gulper.

Right: Extendable catering hoist serving the forward galley.

Toilet service vehicles.

Above: Raising a car on a specially designed platform.

Above: Giant refuelling tanker.

Above: Powered loading platform and 2nd toilet servicing vehicle.

Mobile passenger stairs adjustable to door height.

Powered baggage loading platform in raised position.

Rear galley catering hoist with over-wing walkway.

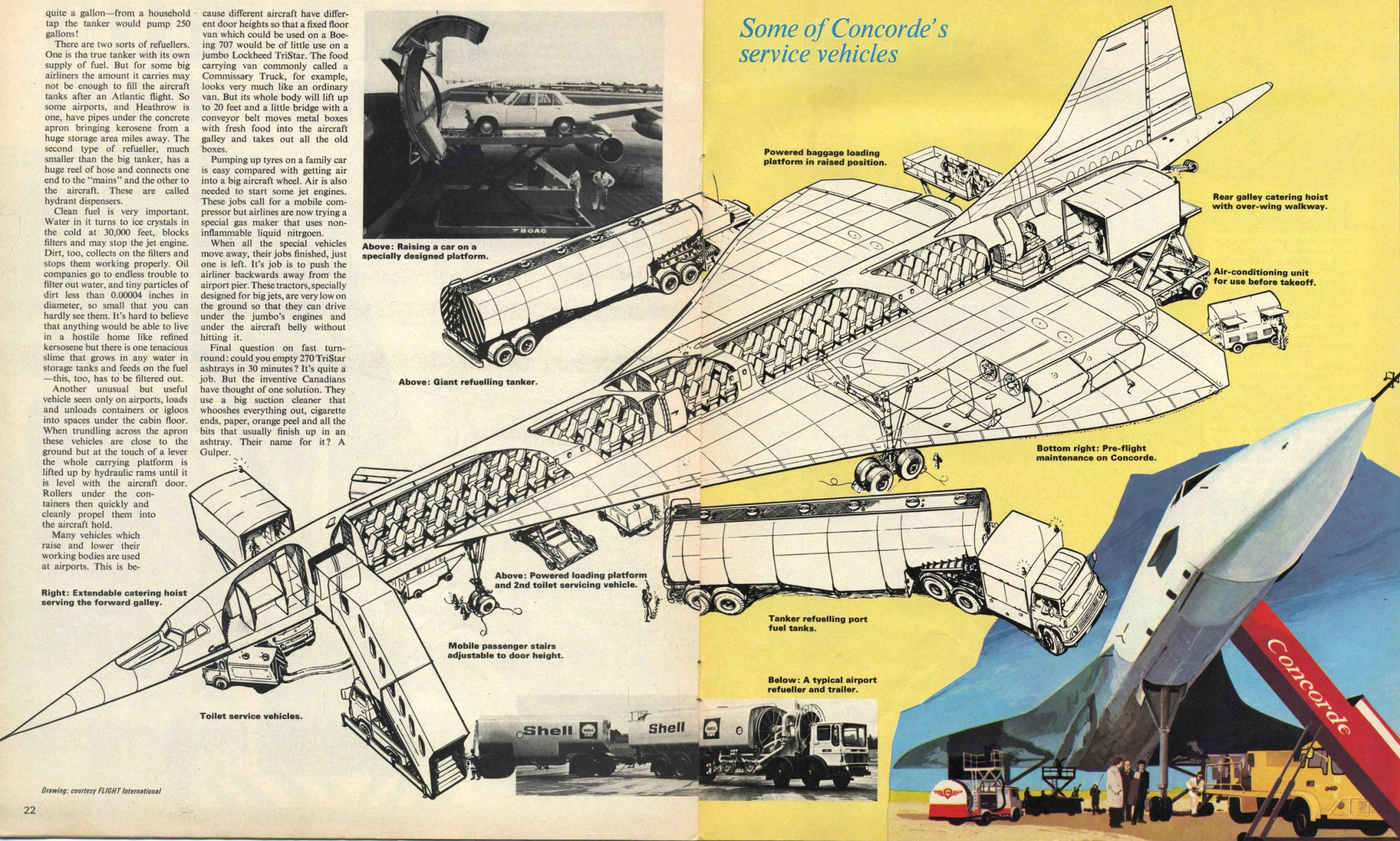
Air-conditioning unit for use before takeoff.

Bottom right: Pre-flight maintenance on Concorde.

Tanker refuelling port fuel tanks.

Below: A typical airport refueller and trailer.

## Some of Concorde's service vehicles





# BETWEEN TWO WORLDS

Arthur C. Clarke Part 8  
JOURNEY TO JUPITER





"You've made space travel a great adventure", said the Administrator.

*No man could make a journey like that of Howard Falcon and remain unchanged. For the first time in years his nightmares had ceased and he felt something like peace of mind.*

'YOU'RE a hero now, Howard,' said Webster, 'not just a celebrity. You've given them something to think about—injected some excitement into their lives. Not one in a million will actually travel to the Outer Giants, but the whole human race will go in imagination. And that's what counts.'

'I'm glad to have made your job a little easier.'

Webster was too old a friend to take offence at the note of irony. Yet it surprised him. And this was not the first change in Howard that he had noticed since the return from Jupiter.

The Administrator pointed to the famous sign on his desk, borrowed from an impresario of an earlier age: **ASTONISH ME!**

'I'm not ashamed of my job. New knowledge, new resources—they're all very well. But men also need novelty and excitement. Space travel has become routine; you've made it a great adventure once more. It will be a long, long time before we get Jupiter pigeonholed. And maybe longer still before we understand those medusae. I still think that one knew where your blind spot was. Anyway, have you decided on your next move? Saturn, Uranus, Neptune—you name it.'

'I don't know. I've thought about Saturn, but I'm not really needed there. It's only one gravity, not two and a half like Jupiter. So men can handle it.'

Men, thought Webster. He said 'men'. He's never done that before. And when did I last hear him use the word 'we'? He's changing, slipping away from us...

'Well,' he said aloud, rising from his chair to conceal his slight uneasiness, 'let's get the conference started. The cameras are all set up and everyone's waiting. You'll meet a lot of old friends.'

He stressed the last word, but Howard showed no response. The leathery mask of his face was becoming more and more difficult to read. Instead, he rolled back from the Administrator's desk, unlocked his undercarriage so that it no longer formed a chair, and rose on his hydraulics to his full seven feet of height. It had been good psychology on the part of the surgeons to give him that extra twelve inches, to

compensate somewhat for all that he had lost when the *Queen* crashed.

Falcon waited until Webster had opened the door, then pivoted neatly on his balloon tyres and headed for it at a smooth and silent twenty miles an hour. The display of speed and precision was not flaunted arrogantly; rather, it had become quite unconscious.

Howard Falcon, who had once been a man and could still pass for one over a voice circuit, felt a calm sense of achievement—and, for the first time in years, something like peace of mind. Since his return from Jupiter, the nightmares had ceased. He had found his role at last.

He knew why he had dreamed about that superchimp aboard the doomed *Queen Elizabeth*. Neither man nor beast, it was between two worlds; and so was he.

He alone could travel unprotected on the lunar surface. The life-support system inside the metal cylinder that had replaced his fragile body functioned equally well in space or under water. Gravity fields ten times that of Earth were an inconvenience, but nothing more. And no gravity was best of all...

The human race was becoming more remote, the ties of kinship more tenuous. Perhaps those air-breathing radiation-sensitive bundles of unstable carbon compounds had no right beyond the atmosphere; they should stick to their natural homes—Earth, Moon, Mars.

Some day the real masters of space would be machines, not men—and he was neither. Already conscious of his destiny, he took a sombre pride in his unique loneliness—the first immortal midway between two orders of creation.

He would, after all, be an ambassador; between the old and the new—between the creatures of carbon and the creatures of metal who must one day supersede them.

Both would have need of him in the troubled centuries that lay ahead.

© Arthur C. Clarke 1972

**NEXT WEEK:**  
An exciting new Arthur C. Clarke story

Howard Falcon, who had once been a man, felt a calm sense of achievement.



"LAND on the port bow, sir". On the bridge of the big trawler homeward bound from the Arctic, the Captain stared in amazement at the lookout's call. His ship was hundreds of miles from land, in the deep, safe waters of the central North Sea and if that was land then his navigator was going to suffer.

The Captain leapt from his chair and peered out through the wheelhouse windows over the smooth sea where dusk was beginning to fall. There, four or five miles over the slate-grey waters, where there should have been nothing, was the squat dark shape of a large island. With a muttered oath the Captain turned to consult his chart, pausing only to bellow into the inter-com for the mate to come to the bridge. His thoughts were interrupted once more by the call of the lookout, this time with a note of excitement, (or was it apprehension?) in his voice. "The island, sir—I think it's moving!"

The island was indeed much more than the imagination of the lookout—and it was also moving. For this was no ordinary island, but a gigantic Man-made structure: a quarter of a million tons of reinforced concrete being towed by a small fleet of tugs. It was destined to form a huge oil reservoir in the middle of the North Sea over the Norwegian Ekofisk oilfield hundreds of feet below the surface.

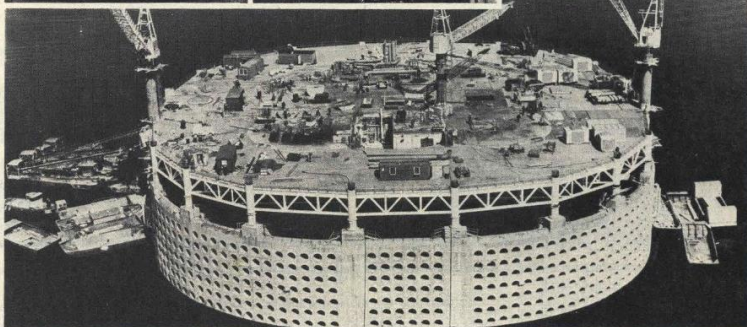
When Phillips Petroleum discovered the rich strike in the middle of the North Sea, they were faced with formidable problems of getting the oil ashore. Oil had been won from under the Sea for years, but never before at such a distance from land and in such deep and stormy waters. The oil rightly belonged to Norway, but between the oilfield and the Norwegian coast lay a deep trench under the sea which made a pipeline impossible. Clearly then, tankers were the answer. These ships would tie up to a huge monobuoy anchored to the sea bottom and load through a floating pipeline from the production platform that actually drew the oil out of the ground. The oil could then be quickly taken ashore.

The only drawback was the weather. Too far away from both Scotland and Norway to make any land shelter completely useless, the great oilfield is completely unprotected. When a northerly gale blows in winter heaping up huge swells as it roars down from the Arctic, the offshore oilmen take shelter where they can on their storm lashed rigs, and take anxious glances at their stand-by rescue craft bobbing about in a sea of spray and white water.

In such conditions no tanker could stay on the berth, but would have to ride out the storm before pumping could be resumed, a



Far left: The Ekofisk One nears the drilling platform. Left: The living quarters platform of the central production complex with a helicopter taking off from the roof pad. Below: The "island" leaves Stavanger in Norway on its journey to the oilfield.



# MAN-MADE ISLAND

*One of the largest structures ever made for the oil men of the North Sea is the Ekofisk One—25,000 tons of reinforced concrete, and afloat!*

costly waste of time. And even more expensive, the machinery that pumped the oil out of the ground and treated it would be idle, too. This was obviously unacceptable, particularly when the number of storms per year was assessed by the meteorologists.

Phillips then came to the conclusion that some sort of reservoir should be built which would enable the oil to be pumped up and treated while the tanker was running over the horizon before some great gale. The company then had to consider what sort of structure could be built to withstand these weather conditions and the deep water. So the idea of the concrete "island" was born.

The immense structure which grew in a quiet, lonely fjord near Stavanger in Norway was nearly 300 feet high, so that nearly 60 feet of it would protrude out of the sea with its base sitting firmly on the sea bottom. The heart of the island was built up of nine

huge storage tanks, capable of holding one million barrels of oil, which is a good three days' production from the field. Around this reservoir, to protect it from the unremitting hammering of the sea, the constructors built a huge, perforated, honeycombed cylinder of prefabricated concrete, designed to let the swirling waters through, but to protect the central tanks from their force. On top of the island, accommodation and service areas were built.

One summer day, a small fleet of powerful tugs gathered in Stavanger Fjord around the concrete island. Residents of the Norwegian port, who had grown used to the great structure on their doorsteps, gathered to watch the tugs connect up and, rather like mice towing a mountain, slowly begin to haul the monster away to sea.

Slowly and steadily, the 40,000 hp of the tugs gradually towed the Ekofisk tank towards its resting

place over the oilfield. Six days after leaving the coast, the little fleet and its huge concrete charge were in position. Heavy anchors were laid to hold the tank steady and one by one the tugs let go. With her valves open, the massive structure began slowly to sink into the grey waters. The moving island had found its resting place.

During the past winter, the Ekofisk island has had a tough trial period with some of the worst weather recorded this century being thrown at it. Snugly, it has sat on the bottom while the storms have raged about it, the cruel North Sea pouring through the perforations in its concrete sides. The Ekofisk tank may be only a man mad island but it behaves as well as a real one. It is also well marked on all the charts and the captains of deep water trawlers will no longer have cause for alarm when their lookouts report an island in the middle of the North Sea.

Photos: Phillips Petroleum Company, Europe/Africa.



Above: The ocean-going tug Simon leads the way as (below) other tugs prepare to tow the massive structure out of the calm waters of the fjord near Stavanger. Rough waters await them in the North Sea.





# Speed & Power

10p

Weekly No. 14

June 21-28, 1974

## The Sea Eagles

Thrilling story  
of the Fleet  
Air Arm

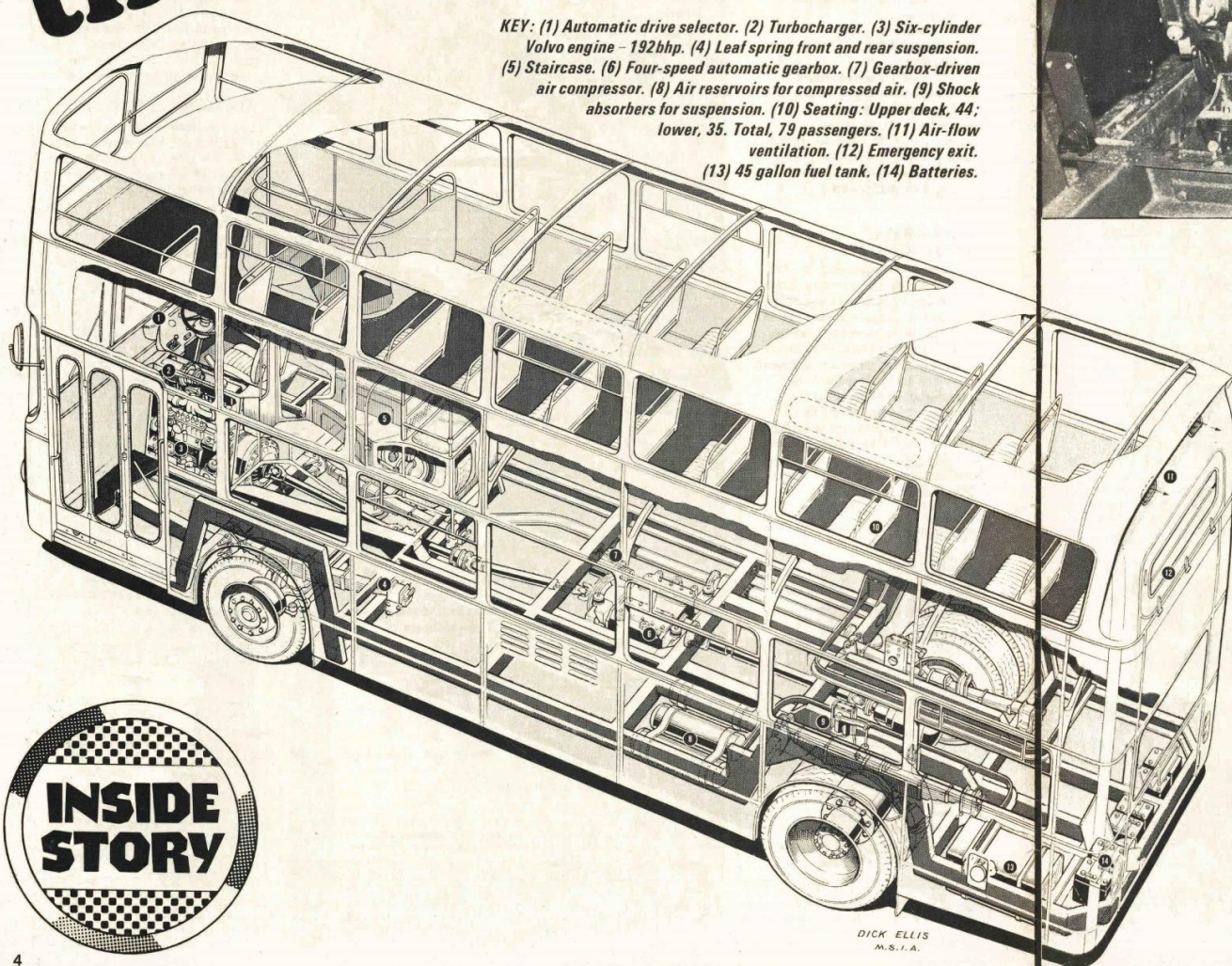
PLANES CARS SHIPS SCIENCE FICTION



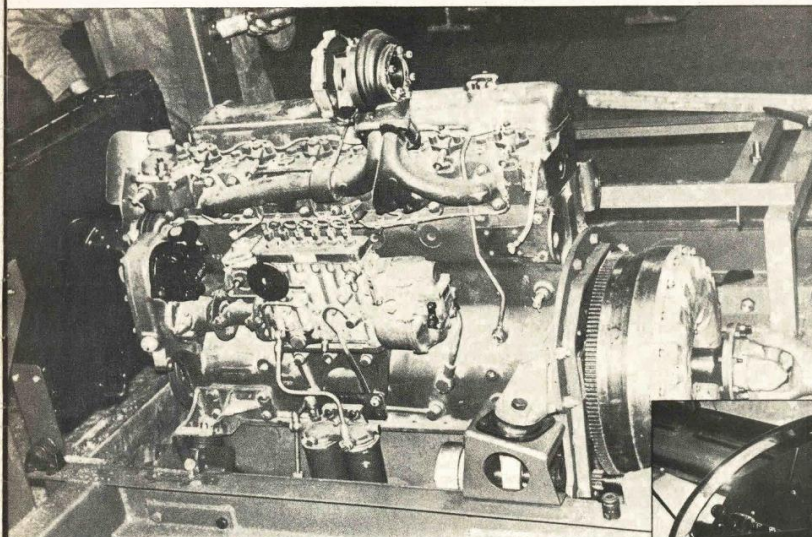
# All Aboard the Ailsa

The one-man-operated, front-engined Ailsa double-decker bus has been designed along simple yet rugged lines and with its power steering and brakes, plus an automatic gearbox, the driver enjoys almost as much luxury as his passengers!

**KEY:** (1) Automatic drive selector. (2) Turbocharger. (3) Six-cylinder Volvo engine - 192bhp. (4) Leaf spring front and rear suspension. (5) Staircase. (6) Four-speed automatic gearbox. (7) Gearbox-driven air compressor. (8) Air reservoirs for compressed air. (9) Shock absorbers for suspension. (10) Seating: Upper deck, 44; lower, 35. Total, 79 passengers. (11) Air-flow ventilation. (12) Emergency exit. (13) 45 gallon fuel tank. (14) Batteries.



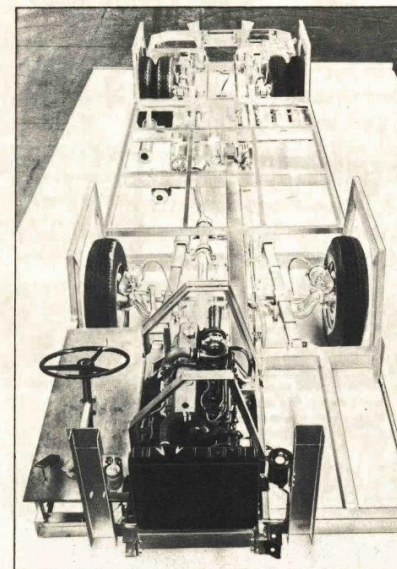
DICK ELLIS  
M.S.I.A.



Left: The 6.7-litre turbocharged Volvo diesel engine which powers the Ailsa bus. The turbocharger, on top of the engine, substantially increases the power output of the engine without sacrificing its small, compact design and reliability. Engine oil capacity is three gallons and the cooling system contains eight gallons of water. Below: The driver's cab is fully instrumented with a speedometer, fuel, air pressure and engine temperature gauges. Warning lights show low oil pressure, whether the parking brake is on, low air pressure and windscreens heating. Rocker switches for the electrical systems are mounted on the right-hand panel.

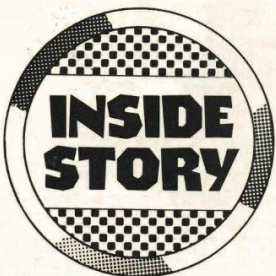


Below: The simple yet sturdy box girder chassis. Once the radiator has been removed the engine can be easily slid out for servicing on a specially designed trolley. Pairs of leaf springs, front and rear, support the axles. The Ailsa will accelerate to 20mph in 14.2 seconds; 30mph in 24 seconds and from 0 to 40mph in 36.6 seconds. Top speed of the bus is an estimated 48mph. Power steering takes the effort out of driving the bus around city streets, and the brakes are power assisted by a compressed air system working at 100 to 114lbs per sq. inch. The passenger entry/exit door, operated by the driver, is also controlled by compressed air. A 24 volt electrical system for the interior lighting is fitted.



Above: Just over 32 feet long, 8 feet wide and 14 feet 6 inches high, the Ailsa weighs 9 tons unladen. The body is built almost entirely from aluminium alloy, while the internal staircase and the driver's cab makes much use of glass reinforced plastic. Cost for each completed bus is between £13,000 and £14,000.

Drawing and photos: courtesy of Commercial Motor





A dramatic aerial photograph showing two VTOL aircraft. The upper aircraft is a Hawker Siddeley Harrier, seen from a low angle, with its large circular air intake visible. The lower aircraft is a Russian Yak-36, also seen from a low angle, with its distinctive canards and star insignia. The background is a bright, hazy sky with a yellowish glow.

The upper aircraft is a Hawker Siddeley Harrier. Below that is a Russian Yakolev Yak-36. Both are VTOL aircraft using 'vectored thrust' engines with swivelling nozzles to control the direction of thrust.

**Conventional aircraft  
need long runways—  
and in times of war  
these are vulnerable to enemy**

**bombers. The Hawker Harrier can operate from an area just  
large enough to hold its menacing shape, and return to lie  
hidden from enemy eyes until its next strike mission.**

# Straight Up Straight Out

**L**URKING in a clearing in the middle of a forest, pilot in the cockpit, aircraft fully armed, a Harrier waits for the order to go. The command comes and the jump-jet fighter lifts off vertically, pirouetting as it climbs above the tree tops and "cleans up" its undercarriage.

Gradually the pilot eases forward his nozzle control lever next to the throttle, and the jet V/Stol fighter makes the transition from jet-borne to wing-borne flight as it accelerates to its target.

This is an operational fighter—in service with the RAF for five years and with the US Marine Corps for four—so jump-jetting is no gimmick. It has very real advantages for the tactical air commander in a fast-changing battle. He wants instant response from his aircraft to knock out enemy tanks and the like before they can do damage. If he has to wait for even a few minutes for aircraft to be called up from rear bases it could be too late.

The Harrier is unique in that it can drop into any clearing and make its base there, so it can always be near at hand for when it is wanted in a hurry. Also, because a squadron can be dispersed over a wide area, the chances of detection and destruction on the ground are

CONTINUED ON NEXT PAGE



very much reduced. Enemy forces know exactly how to disable a conventional fighter force—just attack the runways. With the Harrier that tactic doesn't work. Only a few hundred feet is needed for such take-off runs rather than the thousands of yards required by conventional fighters.

The Harrier—or AV-8A as it is known as in the US Marine Corps service—is the world's only operational V/STOL jet. The Russians, however, are known to be experimenting with a similar plane, and have also flown a number of conventional fighters with small lift jets installed in their fuselages to give them shorter take-offs. So far nothing in the way of operational fighters has come of these experiments, but it can only be a matter of time before the rapidly expanding Soviet Navy is flying V/STOL fighters from its new aircraft carriers. Naval applications for the Harrier would include anti-shipping strikes, air defence, and anti-submarine missions.

Already these techniques have been tried out by the US Marines with AV-8As aboard a small US Navy aircraft carrier, and an order for Harriers to fly from British Through-Deck Cruisers is pending.

The US Marines also want over 300 advanced Harriers, called AV-16s, which may be developed jointly by Hawker Siddeley who make the Harrier and the US McDonnell Douglas company—makers of the Phantom and F-15 fighters already referred to in previous issues of *SPEED & POWER*.

The US Navy is keeping a careful watch on the AV-16 but has also commissioned Rockwell International to produce a "technology prototype" of another V/STOL fighter. In the form in which it will first fly the aircraft will be a bit of a lash up. The nose will come from a A-4 fighter, the air intakes and the main wing from a Phantom.

The aircraft will be a canard configuration—the main wing at the back, with the tailplane at the front. The method by which vertical take-offs will be made is simple in theory but rather more complicated in practice. First there is straight jet lift—you fit small jet engines in the plane with the exhausts pointing down. They are used only for take-off and landing. Another jet provides all the thrust for forward flight.

The jet-lift principle was pioneered in Britain by Rolls-Royce with its flying Bedstead, followed by the Short SC-1 which also had Rolls-Royce engines. The French took up the idea—again using R-R jets—but for an experimental Mirage V/STOL fighter, but it never became operational.

## INTOLERABLE NOISE

Jet lift is also very noisy—which doesn't matter much for military aircraft, but would be disastrous for civil V/STOL airliners. The only real justification for giving an airliner a vertical take-off capability would be to allow it to fly from places close to where the passengers want to start and finish their journeys. So terminals would be close to houses and office blocks. The noise of jet lift would be intolerable.

A descendant of jet lift is fan lift. In this case the small vertical jet engines drive fans which provide the lift. They push a larger volume of air downwards at a lower velocity. This slower moving exhaust makes less noise than does that from the lift jet and would probably be acceptable to landing-pad neighbours.

Various companies—mainly British and German—studied fan-lift airliners in the late 1960s and early 1970s, but found that with up to 16 lift fans needed—plus propulsion engines and the associated stability and con-

trol systems needed for vertical flight—the aircraft were not particularly economic when compared with conventional airliners. They would also have been very expensive to develop.

This would not have been so bad had there been a proven demand for vertical take-off airliners. But it transpired that the airlines were not too interested, because Governments and local authorities had already provided the runways and terminals needed by conventional airlines.

There were also some very real problems to be overcome in what became known as the "infrastructure". For instance, suppose a V/STOL service were to be operated between the city centre of London and Paris, but all London-New York flights still went from Heathrow—quite likely since the V/STOL designs were only for short-range airlines. The passenger wanting to connect between the Paris-London, and the London-New York flights would be faced with a bus or helicopter ride right across London and would be worse off than he is now.

If V/STOL services were to be a success for both the airlines and the manufacturers of the aircraft then large numbers of people would have to be carried and large numbers of planes built. To handle the passengers would require big terminal buildings and to park the planes would require a lot of space. Could that space be found where it was needed or only at existing airports? And if you've got that space, do you really need to take off vertically? Why not use ordinary jets with conventional running take-offs at less cost?

## NOT ATTRACTIVE

These were the problems which led to the end of the fan-lift vertical take-off airliner before it even got off the drawing board, let alone off the ground.

So much for fan-built—nothing wrong with it technically, but for civil applications it was not commercially attractive.

What about vectored thrust? Used by the Harrier, this involves pointing the jet exhaust downwards for take-off and landing, and swivelling it back for forward flight. The Harrier's Rolls-Royce Pegasus vectored-thrust fan jet has four nozzles which rotate to provide the thrust where it is needed.

The front two are supplied with air from the big fan, while the hot jet exhaust passes through the rear two. It's simple, effective and noisy—but that doesn't matter for a military aircraft.

A German V/STOL research aircraft which at one time was to have been turned into a fighter—the VAK 191B—used a combination of vectored thrust and lift-jet engines. It flew successfully but is no longer under active development. An experimental German V/STOL transport aircraft—the DO-31—used a similar

The jet lift propulsion principle of the Rockwell XFV-12A. Key: 1, 2 & 3, downward thrust for vertical take-off and landing, and hovering; 4, 5 & 6, the deflectors in the thrust diverter system are angled during short take-off and landing operations; 7, 8 & 9, how the thrust diverter system looks during conversion to 'straight out' and forward flight.



Above is our artist's impression of a Rockwell International XFV-12A VTOL test plane shown at the two extremes of its speed range—hovering stationary with its undercarriage down and (upper drawing) flying at Mach 2.

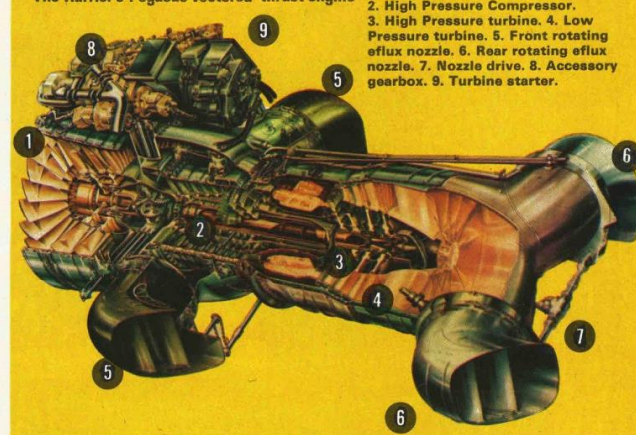
mixture of engines, with a battery of lift engines at its wing tips. There were plans to develop a fan-lift commercial type but they came to nothing.

Tilting the whole wing up and down—complete with engines and propellers—has been tried in the United States and Canada but complication and cost have gone against it.

The latest method of going straight up is being worked on by Rockwell International for its XV-12. This experimental demonstration fighter will use a conventional fanjet engine for forward flight. To take off, however, its exhaust will be blocked shut and the gases will be ducted down the fuselage, and out through slots in the back of special tilting flaps set into both the main and the canard wings. As they are exhausted out of the back of the flaps the gases will tend to suck with them surrounding air and throw it downwards as well. This will provide extra lift and enable a smaller engine to be used than would be possible than if the jet exhaust provided all the lift.

The whole set-up looks a bit complicated and only time will tell whether the XV-12's augmentor flap V/STOL will prove workable, or whether it will fall by the wayside like so many other promising schemes for going straight up. Because, 20 years after the Flying Bedstead first flew, only one vertical take-off jet is in service anywhere in the world—the British Harrier.

## The Harrier's Pegasus vectored-thrust engine



KEY: 1. Low Pressure compressor. 2. High Pressure compressor. 3. High Pressure turbine. 4. Low Pressure turbine. 5. Front rotating efflux nozzle. 6. Rear rotating efflux nozzle. 7. Nozzle drive. 8. Accessory gearbox. 9. Turbine starter.



# One Jump Ahead With

# STAMP

*Look out, here come the Marines . . . of the future! Zooming along at 75mph they are flying high in STAMPs— Small Tactical Aerial Mobility Platforms— now being developed in America to make soldiers more mobile*

STAMPs will have a variety of military roles including manned reconnaissance, river-crossings, amphibious assaults (shown here) and surprise attacks on large fortifications.

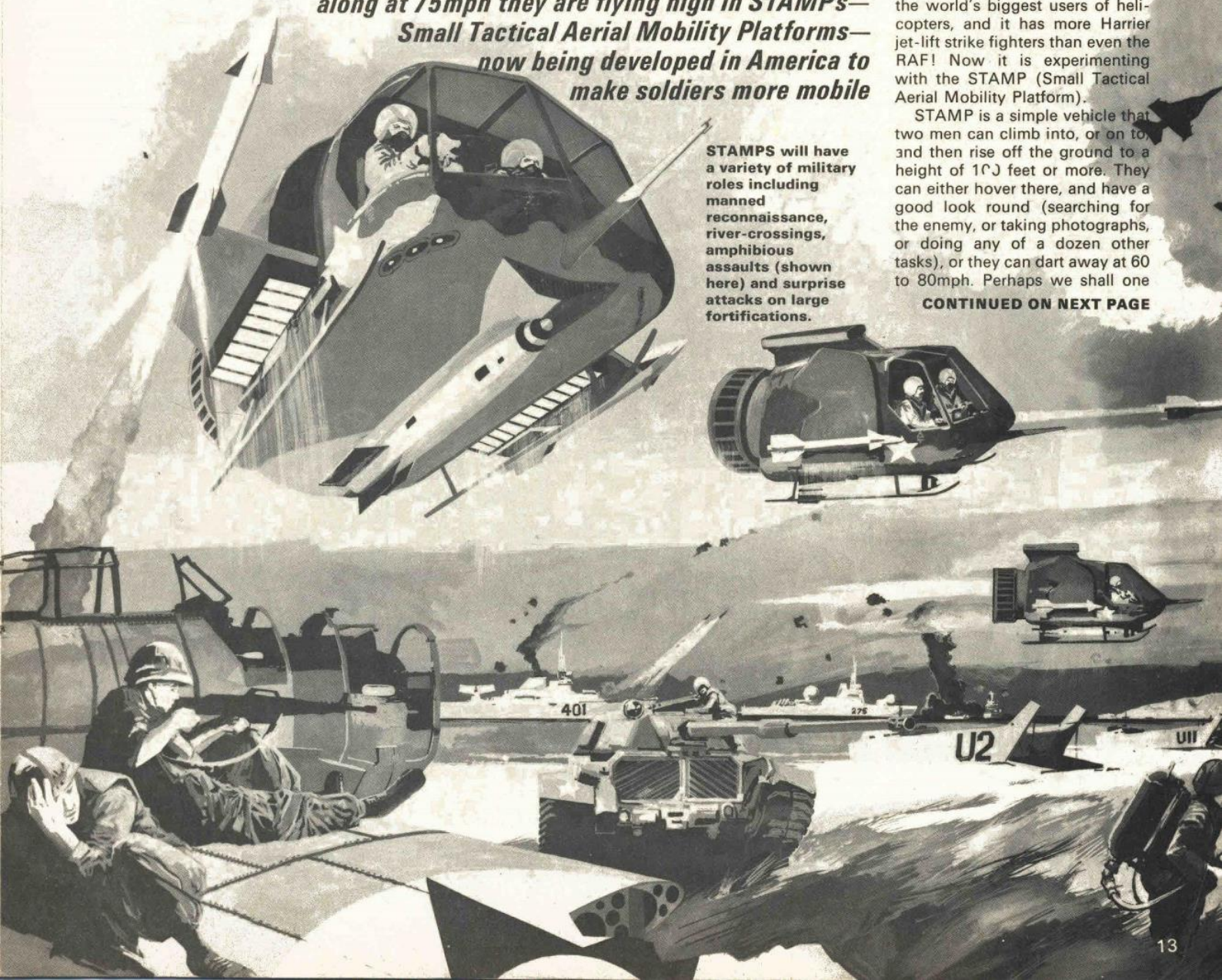
EVER since the British "Flying Bedstead" of 1954, the forerunner of aircraft like the Harrier jump-jet, aircraft designers have been trying to make improved kinds of jet-lift flying machines without wings. Some have done so just for fun, but most have been thinking about possible future battlefields, and how useful it would be to hop about over minefields, fortifications, rivers and forests.

The latest organization to get into the act is the US Marine Corps — the tough "Leathernecks", whose job it would be in any future American conflict to make assaults on enemy beaches and secure bridgeheads in any amphibious invasion.

In the old days the Marines were a cross between navy and army, but today the USMC is very much a flying outfit. It is one of the world's biggest users of helicopters, and it has more Harrier jet-lift strike fighters than even the RAF! Now it is experimenting with the STAMP (Small Tactical Aerial Mobility Platform).

STAMP is a simple vehicle that two men can climb into, or on to, and then rise off the ground to a height of 100 feet or more. They can either hover there, and have a good look round (searching for the enemy, or taking photographs, or doing any of a dozen other tasks), or they can dart away at 60 to 80mph. Perhaps we shall one

**CONTINUED ON NEXT PAGE**





day see thousands of them, so that the ordinary Marine private will have one in his personal kit along with his rifle and water-bottle! It would be just what the Marines have been looking for if every man could soar through the sky to swoop on the enemy from above.

So far, two kinds of STAMP have been built. One, by the Williams Research Corporation of Michigan, is a small turbofan engine standing on end, with simple feet and a place for two men to stand. It will be able to accelerate rapidly, move forward, backwards, and sideways, hover and rotate. On each side is a fuel tank, and on top are simple controls. The whole thing empty weighs 270lb, or about as much as a motorcycle. It is called the WASP (Williams Aerial Systems Platform) and is designed to carry one or two men for up to 30 minutes at speeds up to 60mph.

The two men climb aboard, and in an operational mission would take weapons, binoculars and perhaps a radio (but no parachute because they wouldn't have time to use it). They fire up the little engine and roar off. The jet blasts out of three ducts. The pilot (or is he the driver?) works valves to swivel rows of small deflector vanes or doors in these ducts to tilt the STAMP and make it travel in any direction.

## SPACECOPTER!

The other STAMP machine looks more like a real vehicle—a cross between a spacecraft, and a helicopter whose rotor has come off! The two men sit in comfort under a bubble canopy. The power unit is a 474 hp gas-turbine by AiResearch, a division of the Garrett Corporation, of Los Angeles, who made the whole thing. This engine is geared to a fan which blows air out through a huge duct on each side. Again, rows of reflector vanes are used to deflect and direct the air to control the STAMP and make it go in any direction.

The Garrett STAMP weighs 670lb. It goes a bit faster than the Williams one, at 75mph, but only goes about the same distance (40 miles) on one small tankful of fuel.

The Garrett project is being called the Apteran by the US Marine Corps. Also known as a "flying jeep" it looks like a helicopter because Garrett have used a modified and much lightened fuselage from a Hughes OH-6A chopper. All that remains of the Hughes now is the bubble and the skin under the cockpit.

For military purposes, the

Apteran would be able to swoop down below overhanging branches of trees, could make approaches and landings with its engine switched off, have a lift capability so it could rescue other Apterans in trouble, and would be extremely simple to fly.

It could do almost any job that a conventional light helicopter can do, so it would be useful in many civil applications. Doctors could use it to get to remote towns and places normally approachable only on foot.

Fire services could use STAMP vehicles to take firefighting equipment to areas outside the range of ladders, where lifts are out of action or stairways blocked; and the flying platforms could get forest-fighters to strategic positions quickly and safely. They could also be used by the police and security officers, and by farmers for seed and insecticide spraying.

## LARGER TYPES

The basic Apteran has been designed as a 8 foot by 6 foot by 6 foot unit so it can be fitted into the US Navy's CONEX container for easy shipment, but for civil purposes we could see the flying jeep take on larger and different forms.

Of course, there are still many problems that must be solved before we see STAMP in production. Nobody yet knows the best design, and the two now flying are about as different as chalk and cheese! Cost must be kept down and in battlefield use the Marines who fly the STAMP are going to feel very vulnerable. How would you make it quiet, and cut down the hot parts (enemy guided missiles can automatically home on to any hot metal)? Could the crew make it dart about to avoid enemy fire? Could they lose control? If they did, would there be any way they could escape?

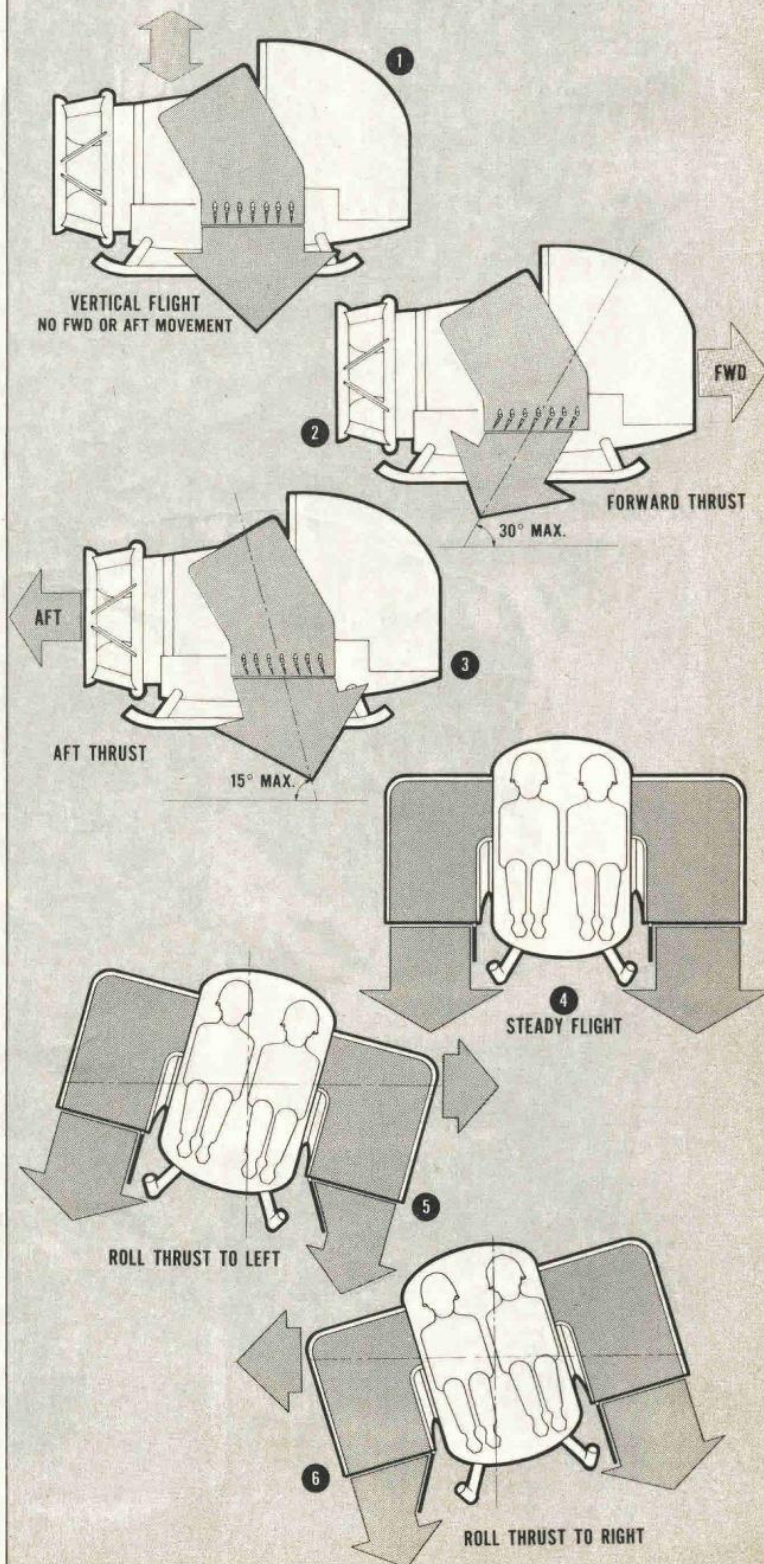
These problems apart, think what fun it would be to have a private STAMP! You could keep it in the smallest backyard and park it almost anywhere. On a couple of gallons of paraffin or petrol you could go 20 or 30 miles, and soar up to the highest building roof, the tallest treetop or even into low clouds.

But you would have to keep your wits about you. STAMP would have no wing or rotor. It could not suddenly change its direction.

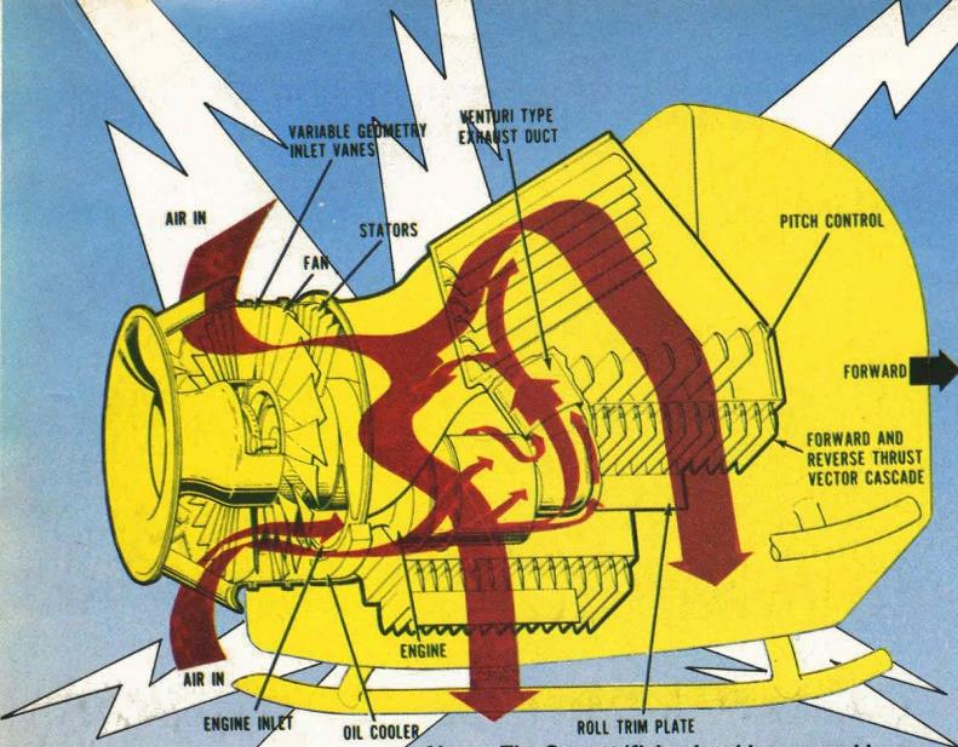
With this kind of vehicle you would have to take decisions well in advance—otherwise you would always be one jump behind instead of one jump ahead!

## HOW THE GARRETT 'FLYING JEEP' IS CONTROLLED IN FLIGHT

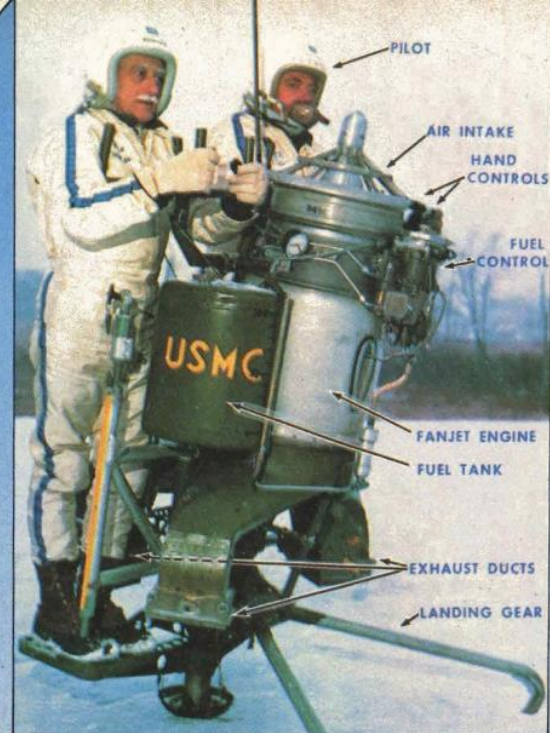
(1) For up or down flight, with no movement forwards or back, the movable thrust vector blades are pointed straight down. (2) Forward movement is achieved by angling the blades back at 30 degrees, giving speeds up to 75mph according to how much power is used. (3) Backwards movement is achieved by pointing the vectoring blades forward at 15 degrees. This control can also be used to provide braking during forward flight with a stopping power that is equal to a car braking quickly on a dry road. (4) (5) and (6) Roll movement for the two-man STAMP is used to help high-speed turning.







Above: The Garrett 'flying jeep' is powered by a fan jet engine which sucks in air through the bell-mouth intake at the rear and exhausts it through the side ducts. Below: The STAMP on flight trials.



The two-man WASP (above) is virtually a flying engine with just some footrests for the crew. Powered by the world's smallest fan jet, the WASP can fly back, forward, sideways and hover. Maximum speed is 60mph and it can stay airborne for 30 minutes. Photo: Williams Research Corp.





# **Speed** **& Power**

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**PLANES**  
**CARS SHIPS**  
**SCIENCE**  
**FICTION**

**CHAMPION OF**  
**CHAMPIONS**



**B-1 SUPERSONIC**  
**BOMBER**



## The Flying Wing Dream Part One

Right: One of Captain John Dunne's flying wing designs powered by a single "pusher" propeller.

An artist's impression of the Spanloader, a futuristic flying wing designed by Lockheed of America. The six-engined wing could carry a payload of 294 tons over a range of 3,800 miles.

# Look! No Tail

Take away an aircraft's fuselage and tail and you've got a flying wing! In the first of a fascinating three-part series we take a look at the history of these almost prehistoric-looking craft that seem to defy all the laws of flying.



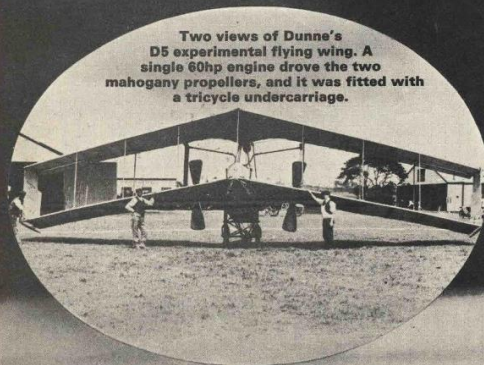
The prehistoric-looking tail-less aeroplane designed by Professor Geoffrey Hill, undergoing flight testing in June 1930.



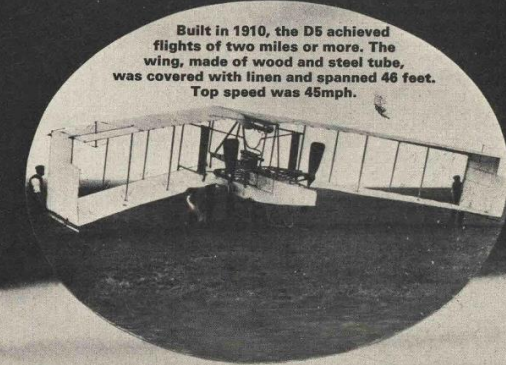
Powered by a 70hp five-cylinder radial engine, the Pterodactyl had a tandem wheel undercarriage and wing skids. The movable wingtips acted as "controllers".



With its pterodactyl symbol painted on its nose, Hill's flying wing looked, and was, an ungainly beast on the ground, but once in the air proved easy to fly.



Two views of Dunne's D5 experimental flying wing. A single 60hp engine drove the two mahogany propellers, and it was fitted with a tricycle undercarriage.



Built in 1910, the D5 achieved flights of two miles or more. The wing, made of wood and steel tube, was covered with linen and spanned 46 feet. Top speed was 45mph.

THE FLYING WING has fascinated aircraft designers for most of the seventy years that the practical aeroplane has been with us. One of its best qualities is its built-in stability and its obvious suitability as an aerial platform for guns and bombs, for observation

or just fare-paying passengers! Oddly enough the true flying wing, with no tail surfaces and with engines and crew housed in the wing structure, has never been produced in large numbers. Northrop in America thoroughly investigated the possibilities with

their series of giant bombers, and one of the last of these, the XB-35, did go into very limited production in the late 1940s. We'll be taking a closer look at these extraordinary aircraft in a future issue.

Recently the whole flying wing dream has been revived, but in a

really massive form. The Lockheed-Georgia Company, a division of the great Lockheed Aircraft Corporation of America who make the Tristar, the Starfighter, the Mach-3 YF-12A and the huge Galaxy (the last two of which were featured in the first issue of *SPEED & POWER*) have just been granted a patent for a flying wing air-freighter, illustrated here.

Invented by Charles H. Hurdkamp, the Spanloader, weighing 535 tons fully loaded (or about the same weight as three empty Jumbo jets), is a possible for the



1980s. Because of the design and construction methods, using special light alloys, the 241 ton Spanloader will be capable of lifting more than its own weight, a staggering 294 tons—more than twice the capacity of the C-5A Galaxy, the present world champion weight lifter.

Because of the sheer weight involved the Spanloader will land and take-off on air-cushions mounted under the wingtips and along the bottom of the fuselage. Six massive engines will power this monster, and with a range of 3,800 miles the Spanloader could cut air-cargo operating costs quite dramatically.

However, for the time being anyway, these are very much flights of fancy, and it is worth while looking back to the very dawn of aviation to trace a pioneer of the flying wing whose ideas must have seemed quite as way out to people then as the Spanloader does to us today.

Captain John W. Dunne, an ex-soldier and close friend of *War of the Worlds* author, H. G. Wells, had, in 1906, designed a biplane flying wing glider. He was at that time working as a designer of man-lifting kites at Farnborough, scene of today's air shows, a position he shared with "Colonel" Cody, a distant relative of "Buffalo Bill" Cody.

His quite revolutionary glider

had been constructed in strict secrecy at Farnborough and it was essential that the flight trials should be flown away from inquisitive eyes. It was arranged that tests should take place on the Duke of Atholl's estate at Blair Atholl in the middle of the Scottish grouse moors.

The Dunne flying wings were crated and

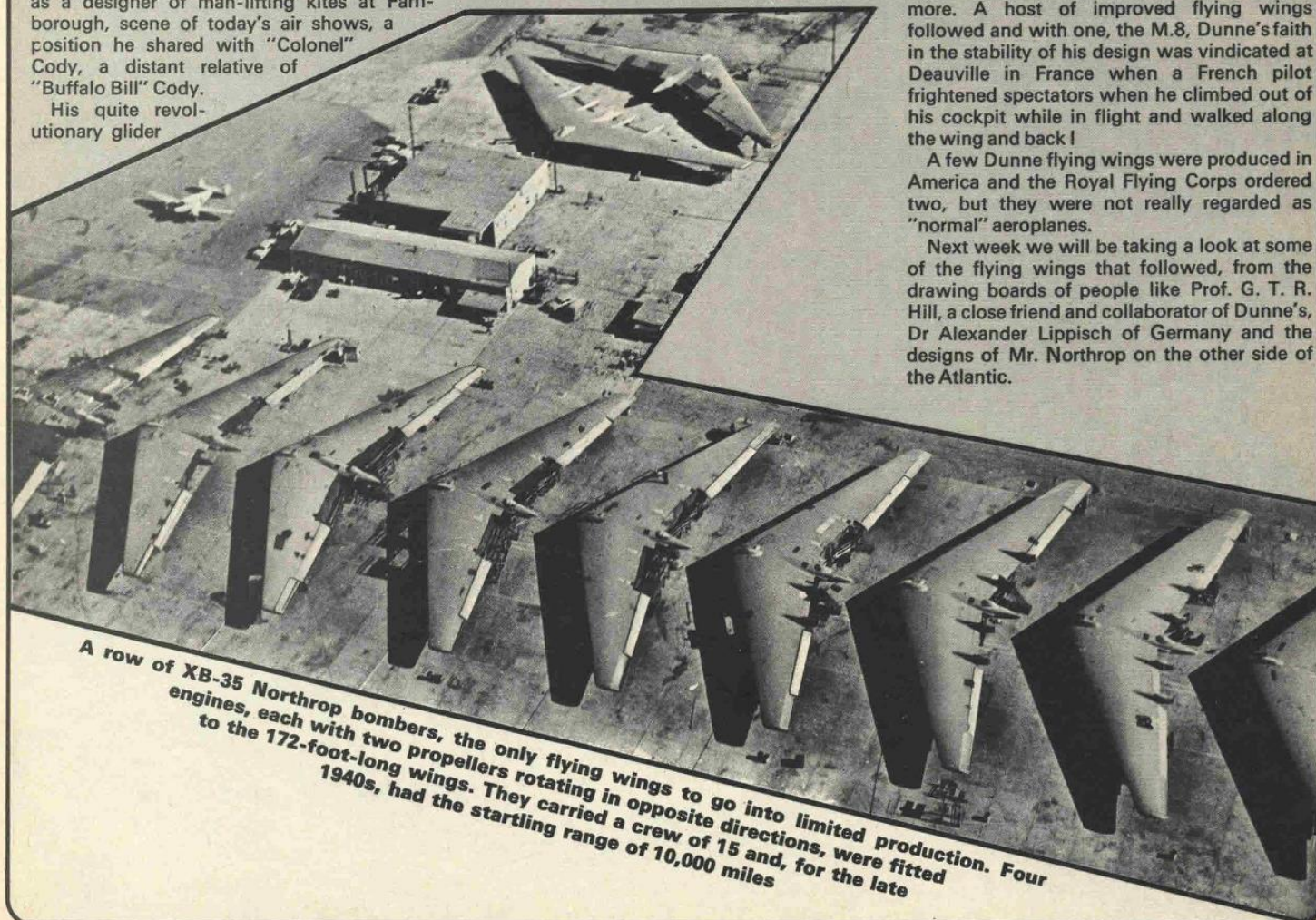
sent by rail, the aviation-minded *Daily Mail* in hot pursuit. The little team gave the newspapers the slip at Perth but not for long. Within three days the story of the mysterious flying wing was printed for all to see. The moors were besieged by curious spectators and even German spies. They were discouraged and misdirected by the local gamekeepers and the trials began in earnest.

Dunne was a sick man with a weak heart and flights were attempted by his boss, Colonel Capper, Superintendent of the Balloon Factory. The first attempts were unsuccessful and ended in crashes. Later, with the aid of low powered engines, the Dunne flying wings began to achieve more than reluctant hops, and at the end of 1908 one of his machines had covered 40 yards. The War Office, however, was not impressed and decided that the £2,500 it had invested in the project had been wasted and withdrew their financial support.

Dunne was not discouraged, and in 1910 Short Brothers built him his Dunne 5. This flew well, achieving flights of two miles and more. A host of improved flying wings followed and with one, the M.8, Dunne's faith in the stability of his design was vindicated at Deauville in France when a French pilot frightened spectators when he climbed out of his cockpit while in flight and walked along the wing and back!

A few Dunne flying wings were produced in America and the Royal Flying Corps ordered two, but they were not really regarded as "normal" aeroplanes.

Next week we will be taking a look at some of the flying wings that followed, from the drawing boards of people like Prof. G. T. R. Hill, a close friend and collaborator of Dunne's, Dr Alexander Lippisch of Germany and the designs of Mr. Northrop on the other side of the Atlantic.

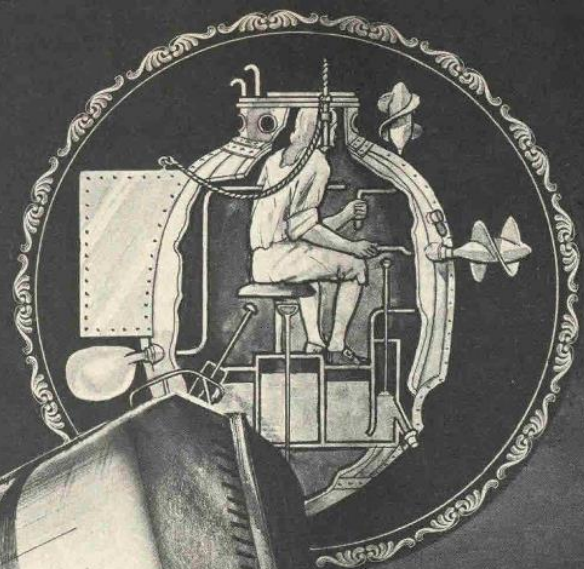


A row of XB-35 Northrop bombers, the only flying wings to go into limited production. Four engines, each with two propellers rotating in opposite directions, were fitted to the 172-foot-long wings. They carried a crew of 15 and, for the late 1940s, had the startling range of 10,000 miles

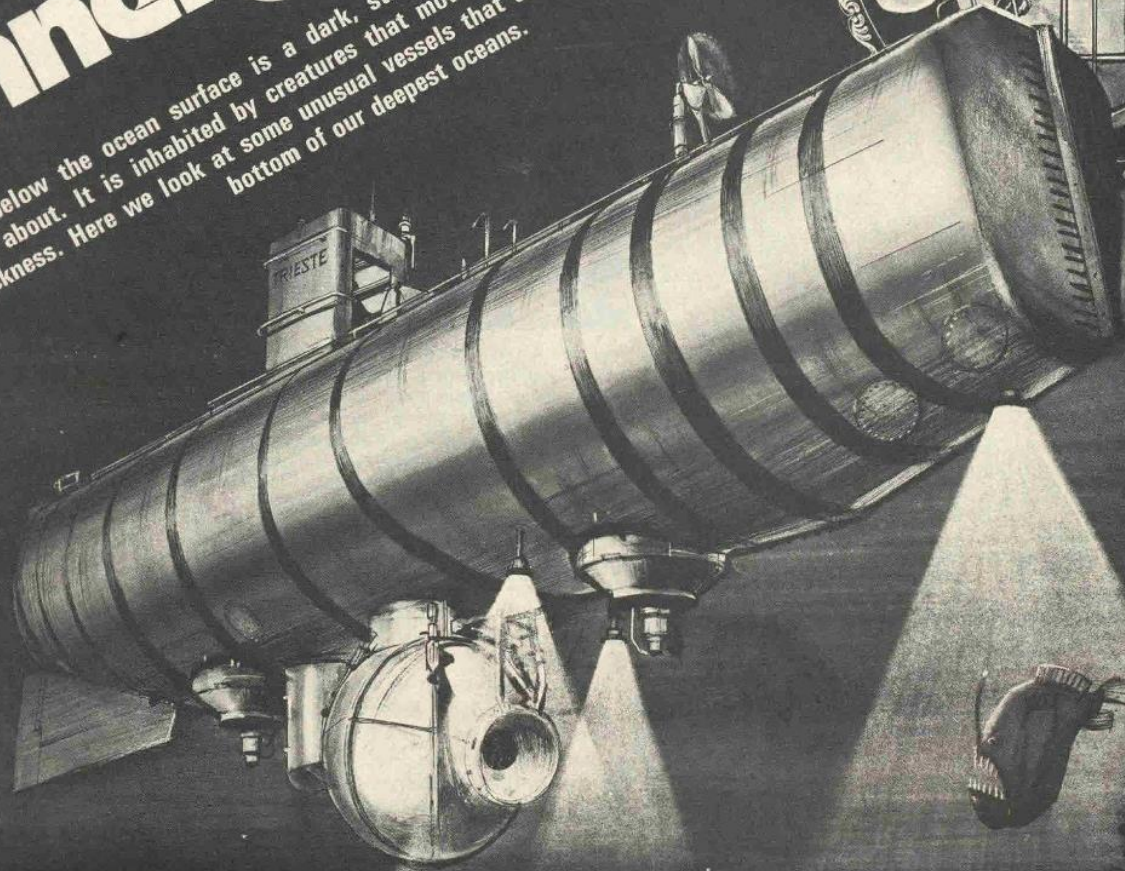


# Exploring Inner Space

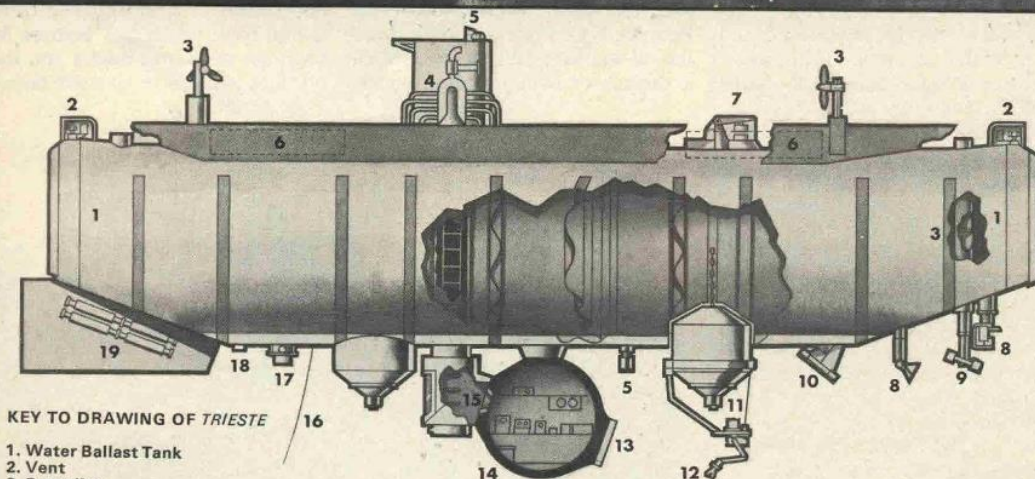
Deep below the ocean surface is a dark, strange world that man knows very little about. It is inhabited by creatures that move silently around through the blackness. Here we look at some unusual vessels that take humans down to the bottom of our deepest oceans.



Left: *Trieste*, a bathyscaph capable of descending seven miles to the floor of the deepest ocean. Inset is the first operational submarine, built in the 1770's to attack a British ship in New York Harbour. It was called *Turtle* and was operated by cranked propellers.



Karl Fretwell



KEY TO DRAWING OF TRIESTE

1. Water Ballast Tank
2. Vent
3. Propeller
4. Fuelling Manifold
5. Underwater Telephone
6. Battery Case
7. Ballast Tub Release Magnet
8. Sonar Transducers (for underwater communication)

9. Television Camera
10. Camera
11. Pellet Ballast Magnet
12. Mechanical Arm
13. Window

14. Observation Sphere
15. Hatch
16. Wire
17. Sound Probe
18. Depth Gauge
19. Anti-Corrosion Anodes

**E**XPLORING inner space—the mysterious ocean depths about which we know so little—is every bit as exciting as the exploration of outer space, the moon and the planets about which we have heard so much over the past decade.

The greatest depth in the oceans is only a little more than 7 miles, but it might as well be 7 million miles away. Inner space is on our doorstep, and yet we have less knowledge of it than we do of what we call outer space around the earth.

The complicated equipment now being used to explore the oceans, and to obtain from them the resources locked up in the water and the seabeds below, is every bit as advanced as that in rockets and space capsules.

Why do we know so little of this inner space? It is because the really

**CONTINUED ON NEXT PAGE**



exciting stage of discovering the treasures held in the oceans has yet to arrive. The development of the science and technology (and the industry) for the oceans will come in the next 10, 20 and 50 years. Today the equipment being used can be compared in its stage of development to the aeroplanes which existed in 1914. Everyone knows how old fashioned those aeroplanes look now. That is, how, in 50 years time, the equipment used for exploring the oceans today will look.

## DESIGNED FOR WAR

One of the world's first submarines was built in 1776. It was designed by an American called David Bushnell, and shows that the beginning of undersea operations occurred a long time ago. Bushnell's submarine was designed for war use and it has usually been wars which have caused man to move further and further into the ocean.

Nevertheless the depths to which military underwater vehicles could go was measured in mere hundreds of feet, and it was not until 1960 that the bathyscaphe *Trieste*, operated by the United States Navy in co-operation with Jacques Piccard, reached the bottom of the deepest known part of the ocean, the Challenger Deep at the southern end of the Mariana Trench in the Pacific. The Challenger Deep itself was named after the Royal Navy's *HMS Challenger*, the ship which carried out surveys of the world's ocean in the last century.

The chart on page 15 shows what the ocean bed would look like if the water was taken away. It is an exciting, mysterious and varied world, one which will be explored and worked in by the explorers of the 1980s and 1990s.

## DANGEROUS DIVING

It is no more possible for man to go to the bottom of the ocean unaided than it is for man simply to move off into space. In the Pacific some native men will dive for pearls in a hundred or so feet of water. But skin-diving in deep water can cause decompression sickness due to nitrogen bubbling out of the blood as the diver comes to the surface. This can cause unconsciousness or even death. Man must either go down to the ocean depths in a pressure suit which will protect him against the high external pressure, or he must go down in a complete submersible which will enable him to move around as an astronaut.

A new British diving suit, called

JIM, made from magnesium alloy, is now being tested and will allow men to go deeper than 1,000ft. without their bodies being subject to any water pressure. Of the submersibles, most are small and will carry just one, two or three men. The best known in Great Britain is the *Pisces* which is now carrying out much work concerned with bringing oil from the North Sea.

Two American examples are a research vessel called *Nemo*, whose pressure sphere is made entirely from plastics so that a man may sit inside and see all that goes on around him, and the *Aluminaut* which, like *Pisces*, has manipulators at the front to carry out simple tasks.

## DIFFICULT PROBLEMS

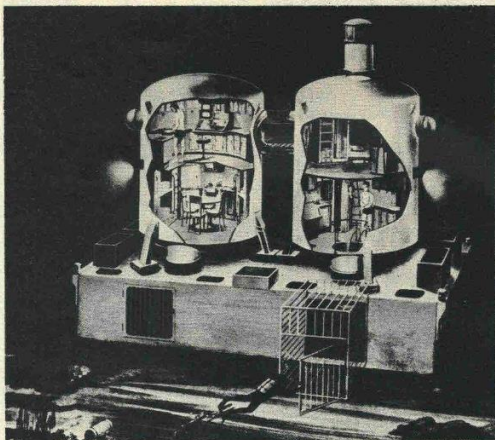
But the depths to which these vehicles can operate is relatively limited at present—a few thousands of feet—whereas the bathyscaphe *Trieste* used for reaching the bottom of the Challenger Deep had to be made from an enormously thick steel sphere to withstand the tremendous pressure.

The air pressure at sea level is 15lb on every square inch, and by descending 30ft. into water the body is subject to another 15lb per square inch of pressure, or twice what the body stands when on the surface. But the pressure exerted at the bottom of the deeper parts of the ocean is *twelve hundred* times the pressure on the Earth's surface. To go into outer space man's equipment must be designed to deal with change of pressure from 15lb per square inch to zero. To go to the bottom of *inner* space, man's equipment must be designed to withstand pressures which change from 15lb per square inch to 18,500lb per sq. inch. So that in a way, the problems of exploring the oceans are more difficult than outer space.

The industries working in the oceans are drilling for gas and oil, and are just beginning to search for other minerals such as manganese nodules lying on the beds of the deep oceans. At present oil and gas are being brought up in water depths of only a few hundred feet, but some of the problems of even this have been made clear recently when one or two of the exploration rigs have broken up in the fierce weather of the North Sea. Yet the North Sea is, almost everywhere, no deeper than 600ft.

If oil or gas is discovered it is usual at present to put in a fixed drilling platform and this is what is going to be used by British Petroleum for their Forties Field.

The size of one of these structures is enormous, as is shown compared

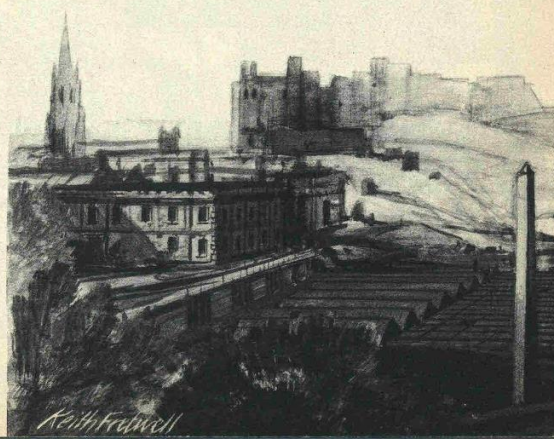


Above: An artist's impression of a special unit in which aquanauts could live and work, conducting experiments in the bleak blackness of the deepest oceans. It is called 'Tektite' and would incorporate a dining room (lower floor of left-hand chamber), a laboratory for conducting experiments (upper floor), diver's dressing and equipment room (lower floor, right-hand chamber) and bedroom (upper floor). The chambers are connected by a tunnel

with the buildings of Edinburgh. Already, four such structures are going to be used for the Forties Field alone, and each of them by the time it is installed will have cost £50 million.

When we go deeper or when we move to rougher, less friendly waters to the west of the Shetland Islands where Shell are now drilling, it is likely that seabed production systems will have to be considered. Two companies are designing these at present. One is SEAL Petroleum and the other is the Lockheed Petroleum Company. In both cases the oil wellhead will be covered by a capsule or container into which

man can be put. It seems likely that this is the way in which the future development of underwater exploration will go so that man is not subject to the enormous pressures at great depths. But the designing of equipment which can keep out these enormous pressures is still near the limits of known technology. Next week we will look a little more closely at one of these seabed production systems, at systems for recovering manganese nodules from the middle of the Pacific, and at the new breeds of hydrofoil and catamaran boats which may perhaps be common support vehicles for the offshore industry in 10 years time.



Left: The research submarine *Aluminaut* glides over the ocean floor. Note the strange "claws" used to pick samples off the sea bed. Below (inset): A map of the Atlantic Ocean floor. Below: Oil rigs drill hundreds of feet into the bed. To show the giant size of these monsters, our artist has drawn an oil rig as it would appear if placed in the streets of Edinburgh.





# SUPERSONIC BOMBER



**T**HE SLEEK, vicious-looking bomber sprints towards its target at nearly the speed of sound just above the rooftops. Hugging the ground, it comes in so low and fast that the enemy are caught by surprise. They are expecting something at high altitude. Low flying bombers are not so easy to spot on ground radar. . . they strike and are away in a flash. And when they are high in the sky they can fly at twice the speed of sound, so that you have to be quick to get a pot at them with anti-aircraft missiles.

Aircraft like this don't exist today, but this is no dream; it is a realistic look at the future of an advanced bomber being built and tested right now for the United States Air Force. It is called the B-1 and, although it is big, powerful and capable of different methods of attack, its main job will

***High-flying at faster than twice the speed of sound, low-flying to cheat enemy radar defences, the B-1 swing-wing bomber is being built to defend the United States into the next century. And if the crew get into trouble, the whole cockpit will eject and float them safely to the ground.***

be to *prevent* war for the next quarter of a century. After all, which country is going to pick a fight when its enemy is better armed?

For over 20 years the United States have had an armada of the mighty B-52 Stratofortress bombers, but their age is beginning to tell. And before long Russia will have what we call "Backfire"—a strategic bomber able to fly faster than twice the speed of sound. So the US are having to build their own super-

sonic bomber to take over from the ageing B-52 and match the Soviet "Backfire".

The planemakers given the job of designing and building an aircraft such as the world has never seen before are North American Rockwell who have a long tradition of building high-performance warplanes.

In World War II, North America came up with the famous P-51 Mustang fighter and B-25 Mitchell bomber. During the Korean war their F-86 became the first Western

swept-wing fighter to be used in anger. . . and it did well.

Really high-speed experience came with the firm's X-15 research aircraft; one of those reached a speed of 4,250mph—over six times the speed of sound! Another of these dart-shaped rocket planes climbed to an altitude of 354,200 feet—more than six miles above Earth—and earned five of its pilots astronaut's wings!

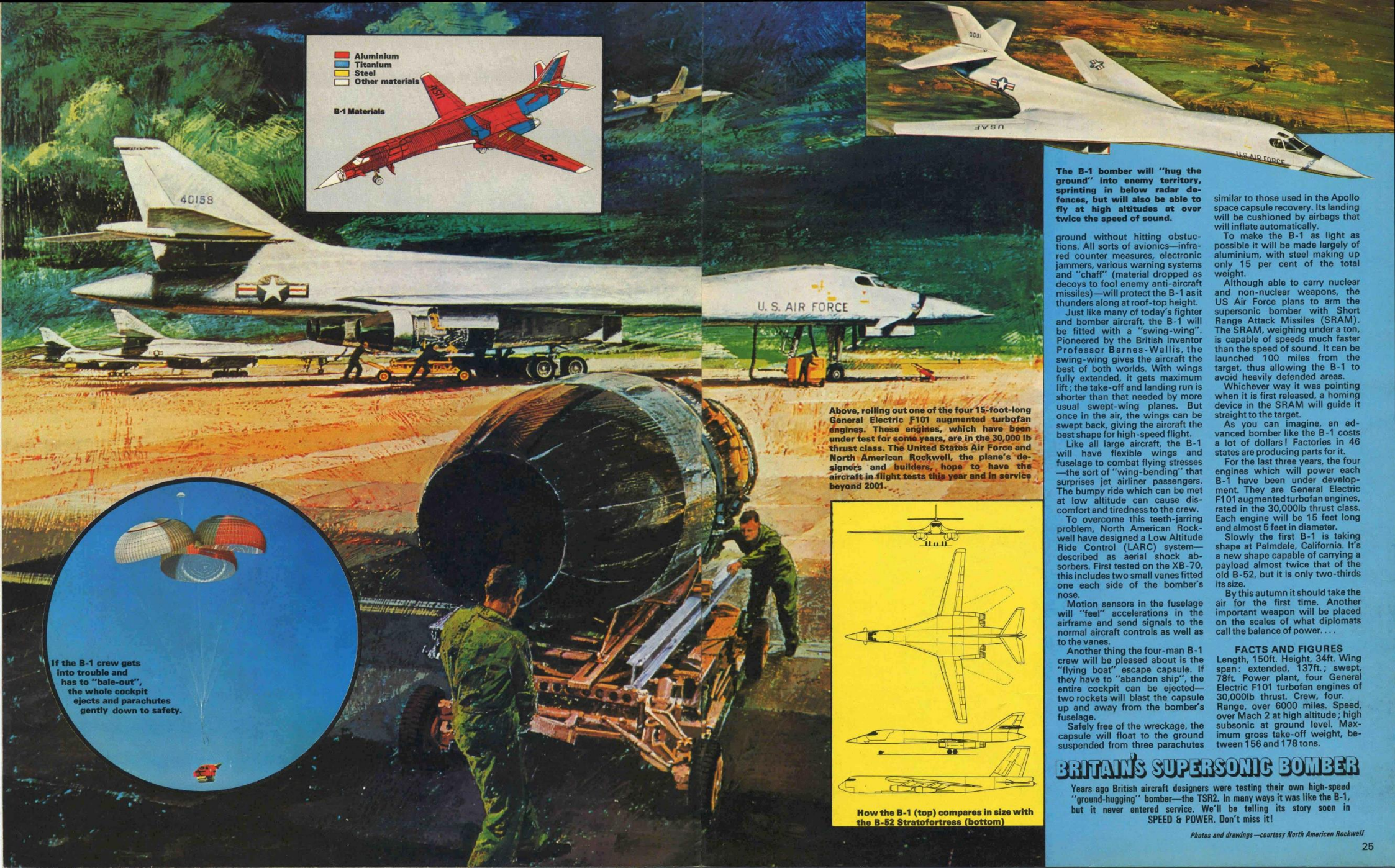
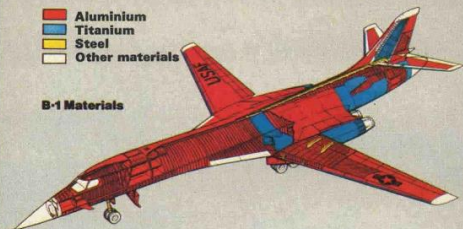
So North American Rockwell seems a natural choice to build a supersonic bomber like the B-1, able to slip into enemy territory beneath the radar screens. Today, radar defences are so good that a high-flying bomber can be quickly picked up and attacked by anti-aircraft missiles.

But the B-1 will have its own radar system operated by computers so that it will be able to fly just a few hundred feet above the



■ Aluminium  
 ■ Titanium  
 ■ Steel  
 ■ Other materials

B-1 Materials



Above, rolling out one of the four 15-foot-long General Electric F101 augmented turbofan engines. These engines, which have been under test for some years, are in the 30,000 lb thrust class. The United States Air Force and North American Rockwell, the plane's designers and builders, hope to have the aircraft in flight tests this year and in service beyond 2001.

If the B-1 crew gets into trouble and has to "bale-out", the whole cockpit ejects and parachutes gently down to safety.

The B-1 bomber will "hug the ground" into enemy territory, sprinting in below radar defences, but will also be able to fly at high altitudes at over twice the speed of sound.

ground without hitting obstructions. All sorts of avionics—infrared counter measures, electronic jammers, various warning systems and "chaff" (material dropped as decoys to fool enemy anti-aircraft missiles)—will protect the B-1 as it thunders along at roof-top height.

Just like many of today's fighter and bomber aircraft, the B-1 will be fitted with a "swing-wing". Pioneered by the British inventor Professor Barnes-Wallis, the swing-wing gives the aircraft the best of both worlds. With wings fully extended, it gets maximum lift; the take-off and landing run is shorter than that needed by more usual swept-wing planes. But once in the air, the wings can be swept back, giving the aircraft the best shape for high-speed flight.

Like all large aircraft, the B-1 will have flexible wings and fuselage to combat flying stresses—the sort of "wing-bending" that surprises jet airliner passengers. The bumpy ride which can be met at low altitude can cause discomfort and tiredness to the crew.

To overcome this teeth-jarring problem, North American Rockwell have designed a Low Altitude Ride Control (LARC) system—described as aerial shock absorbers. First tested on the XB-70, this includes two small vanes fitted one each side of the bomber's nose.

Motion sensors in the fuselage will "feel" accelerations in the airframe and send signals to the normal aircraft controls as well as to the vanes.

Another thing the four-man B-1 crew will be pleased about is the "flying boat" escape capsule. If they have to "abandon ship", the entire cockpit can be ejected—two rockets will blast the capsule up and away from the bomber's fuselage.

Safely free of the wreckage, the capsule will float to the ground suspended from three parachutes

similar to those used in the Apollo space capsule recovery. Its landing will be cushioned by airbags that will inflate automatically.

To make the B-1 as light as possible it will be made largely of aluminium, with steel making up only 15 per cent of the total weight.

Although able to carry nuclear and non-nuclear weapons, the US Air Force plans to arm the supersonic bomber with Short Range Attack Missiles (SRAM). The SRAM, weighing under a ton, is capable of speeds much faster than the speed of sound. It can be launched 100 miles from the target, thus allowing the B-1 to avoid heavily defended areas.

Whichever way it was pointing when it is first released, a homing device in the SRAM will guide it straight to the target.

As you can imagine, an advanced bomber like the B-1 costs a lot of dollars! Factories in 46 states are producing parts for it.

For the last three years, the four engines which will power each B-1 have been under development. They are General Electric F101 augmented turbofan engines, rated in the 30,000lb thrust class. Each engine will be 15 feet long and almost 5 feet in diameter.

Slowly the first B-1 is taking shape at Palmdale, California. It's a new shape capable of carrying a payload almost twice that of the old B-52, but it is only two-thirds its size.

By this autumn it should take the air for the first time. Another important weapon will be placed on the scales of what diplomats call the balance of power. . . .

#### FACTS AND FIGURES

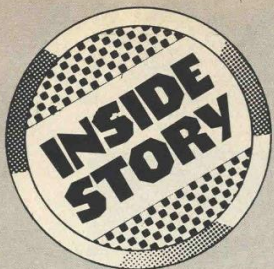
Length, 150ft. Height, 34ft. Wing span: extended, 137ft.; swept, 78ft. Power plant, four General Electric F101 turbofan engines of 30,000lb thrust. Crew, four. Range, over 6000 miles. Speed, over Mach 2 at high altitude; high subsonic at ground level. Maximum gross take-off weight, between 156 and 178 tons.

## BRITAIN'S SUPERSONIC BOMBER

Years ago British aircraft designers were testing their own high-speed "ground-hugging" bomber—the TSR2. In many ways it was like the B-1, but it never entered service. We'll be telling its story soon in **SPEED & POWER**. Don't miss it!

Photos and drawings—courtesy North American Rockwell





ON OCTOBER 1, 1973, at 2.30 in the afternoon in the Gulf of Mexico, Diamond M Rig 90 burst into flames and within minutes the whole deck was ablaze.

Twenty-seven men were working on the oil rig at the time of the accident, but all survived—thanks to an unusual survival system called the Whittaker capsule.

Men working on off-shore oil rigs have a dangerous job and it is because of this that the Whittaker Survival system has been designed to provide a means of escape when danger threatens. As burning oil can quickly turn a rig into an inferno, a speedy escape method is essential and the capsule has been built so that up to 28 men can be evacuated in just 60 seconds!

Even if burning oil covers the surface of the sea beneath the rig the Whittaker capsule, being made of fire-resistant materials, can carry its human cargo to safer waters.

It is often necessary to evacuate an oil rig which is being pounded by heavy seas. Indeed, sometimes a drilling platform may be listing dangerously because a leg has been broken or damaged in a storm.

The simple launching system for the capsule has been designed to cope with such a situation. Although the winch that lowers it to the sea is powered by electricity, if the power fails the capsule can be quickly wound down by a crew member.

Once in the water, a 40hp. marine engine will power the capsule out of trouble. This is very important because there is often a dangerous "undertow" near the legs of an oil rig and the Whittaker capsule is made to be easily manoeuvred.

A helicopter diverted to the scene of the fire aboard the Diamond M rig arrived in time to see the launching of the Whittaker

capsule. The pilot of the helicopter watched as the little capsule first moved away from the blazing rig and then returned to pick up four stranded survivors who had been injured in the blaze. Radio contact with the shore base was made from a radio in the capsule, and within a short time boats arrived on the scene to ferry the survivors to safety.

But what if there are no boats so close at hand? The designers of the capsule have tried to think of every possible emergency. For example, the doughnut-shaped craft is built of glass fibre-reinforced plastics and it cannot be capsized.

And if, in spite of the bright orange colour and special materials which reflect radar signals, the capsule is not quickly found by search aircraft and ships, there are enough "life support" facilities on board to meet the needs of the survivors for five days. Food and water are kept in water-tight compartments. In fact, with the doors closed the capsule itself is water-tight.

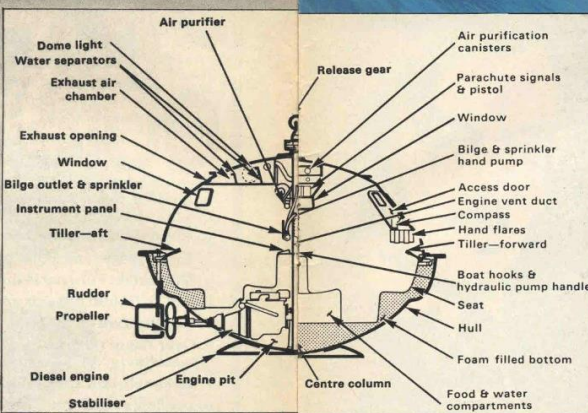
Everything from a signalling mirror to boxes of matches is stored neatly away in the capsule,

for in a long storm the 28 men may well have to fend for themselves until rescue boats can find them.

Over 300 capsules have been installed on rigs in many parts of the world. One reason for their wide use is the ease with which they can be used for training. Just as lifeboat drill is carried out on ships, so on the oil rigs practice escapes can be made with the Whittaker capsule. This ensures that, should disaster strike, the men on the rig are familiar with the system, and trained to pile into the little craft quickly.

Let us take a look inside the capsule. Its shape is not unlike the rubber dinghies carried by large aircraft, being circular in shape with a domed roof. Once inside we can see that good use has been made of all available space. Twenty-two seats are fitted around the outside of the cabin with the occupants facing inwards. By one of them is the tiller by which the capsule can be steered.

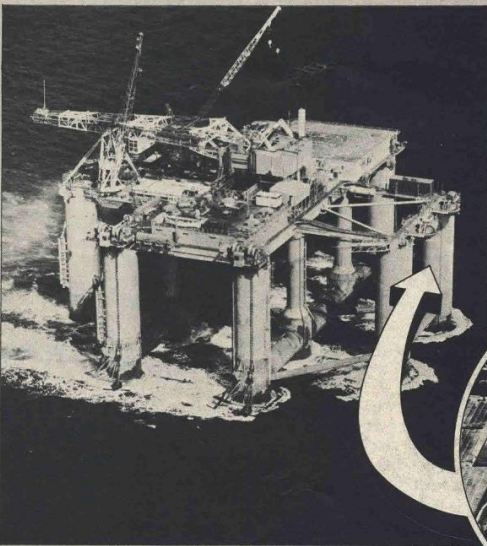
A further six seats—and a toilet—are located in the middle, the occupants facing outwards. Also in the centre are the waterproof food and water compartments, and the "Westerbeke" Model



4-107 diesel engine. At a steady five knots, the Whittaker capsule is not going to break any speed records, but it is fast enough for the operator to get well away from the danger area. A "blow out" from a natural gas well, for example, can be dangerous enough for the survivors to be grateful for the hour's air supply the capsule will give them after launching.

Boathooks, signal flares, compass and engine instrument panel are all located in the centre of the capsule.

The British company, Elliott & Garrod, is fitting more and more of the Whittaker Survival Systems to the growing number of oil and gas rigs operating in the North Sea. Although they do not give ocean liner comfort, they quickly get oil rig crews out of dangerous situations—and that's worth a little discomfort!



Over 300 Whittaker escape capsules are now installed on rigs all over the world. Each dome-shaped craft has room for 28 men and in the event of a fire can be quickly lowered into the sea. A small marine engine is then used to power it clear of the disaster.



RIG... ESCAPE CAPSULE... ESCAPE CAPSULE... ESCAPE CAPSULE...



# Speed

## & Power

10p Weekly  
No. 16 July 5-12, 1974

**MIDGETS  
HIT THE  
BIG TIME**

**CHAIRMEN  
OF THE  
RACE TRACK**





LAST WEEK we touched on the earliest flying wing experiments of L. J. W. Dunne and the most recent project of the Lockheed company of America with their giant Spanloader project, still on the drawing board, but scheduled for the 1980s. This week we begin filling in the 60 years between these two different flying wing projects and we look at the efforts of two British pioneers, stretching from the 1920s through to the late 1940s.

Prof. G. T. R. Hill, born in 1895, had become deeply interested in slow speed flight and aerodynamic safety. Early on he had been influenced by Dunne and in the twenties was making flying wing models and producing many drawings of tailless aircraft. Although his designs were not true flying wings they were very close and had similar flying characteristics. His first design to pass beyond the drawing board was built with the help of his wife in 1924.

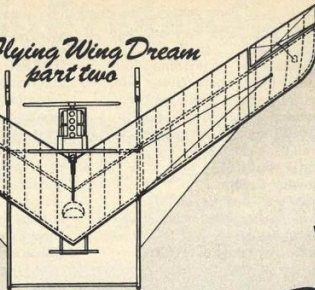
Hill called this and all subsequent tailless designs the Pterodactyl, named after the prehistoric winged reptile. It was made of wood and had a wing span of 45ft. and 31 degree sweepback. Instead of normal elevator and aileron controls it incorporated pivoted wing-tip sections called "controllers", later known as elevons. These controllers served the dual purpose of providing latitudinal and longitudinal control. The gliding tests were made from the South Downs where the Pterodactyl was

launched by means of an elastic rope. These flights were so successful that later on a baby 32hp engine was fitted and in this form it was first flown on December 3, 1925.

In 1928 Prof. Hill joined the Westland aircraft company at Yeovil (today this company is Britain's largest helicopter manufacturer) where he made use of the company's facilities to continue his researches.

The first product of this partnership was the Pterodactyl 1A. The Air Ministry and the rest of the aircraft industry began to watch with interest and Hill's next design was a side by side two-seater powered by a variety of pusher engines (this was illustrated in Part One of the Flying Wing story in last week's *SPEED & POWER*). It was rebuilt and updated at least twice and later incorporated elevons and flaps.

*The Flying Wing Dream  
part two*

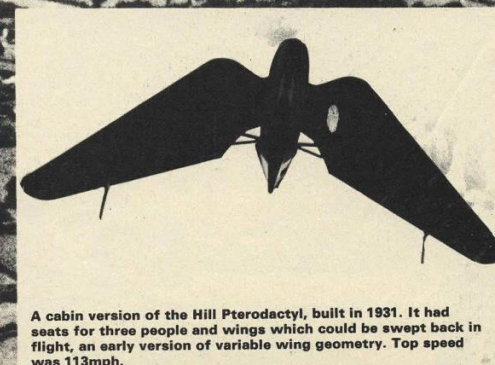


# Fighting Pterodactyls

The first powered Pterodactyl built by Prof. Hill. Fitted with a tiny 32hp engine, it was first flown in December, 1925, and is now preserved in the Science Museum, London.



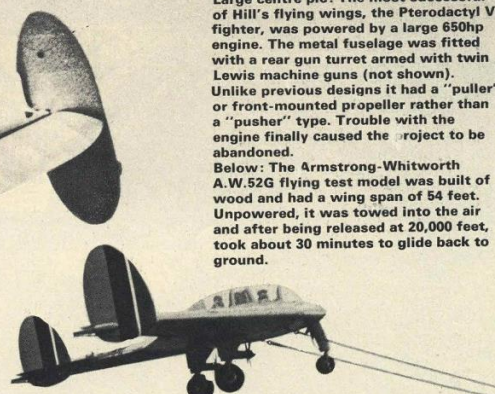
Another view of A.W.52 in flight. The advantages of such a design mean a saving in weight and extra drag caused by a fuselage and tail and a better airflow over the wing.



A cabin version of the Hill Pterodactyl, built in 1931. It had seats for three people and wings which could be swept back in flight, an early version of variable wing geometry. Top speed was 113mph.

Large centre pic: The most successful of Hill's flying wings, the Pterodactyl V fighter, was powered by a large 650hp engine. The metal fuselage was fitted with a rear gun turret armed with twin Lewis machine guns (not shown). Unlike previous designs it had a "puller" or front-mounted propeller rather than a "pusher" type. Trouble with the engine finally caused the project to be abandoned.

Below: The Armstrong-Whitworth A.W.52G flying test model was built of wood and had a wing span of 54 feet. Unpowered, it was towed into the air and after being released at 20,000 feet, took about 30 minutes to glide back to ground.



The A.W.52 which roared into the air in November, 1947, powered by two Rolls-Royce turbo jets buried in the 90 foot wingspan. It was a single seat aircraft. During one test flight the whole wing began to shake violently, causing the pilot to eject. The trouble then righted itself, and the "wing" continued to fly on across open country until it made a pilotless landing, almost undamaged!



Progress and development was swift and the Pterodactyl V of 1932 was perhaps the most interesting of all. It was a metal-built turret fighter with its 650hp Goshawk engine installed in the front. An electrically operated gun turret firing two Lewis guns was situated behind the pilot. The advantages of this layout are apparent from the accompanying photograph. Just look at the wide arc of fire for the gunner. The idea was sound but unfortunately the Goshawk engine was troublesome and a complete redesign of the airframe would have been unavoidable to cure the problems, and it came to nothing.

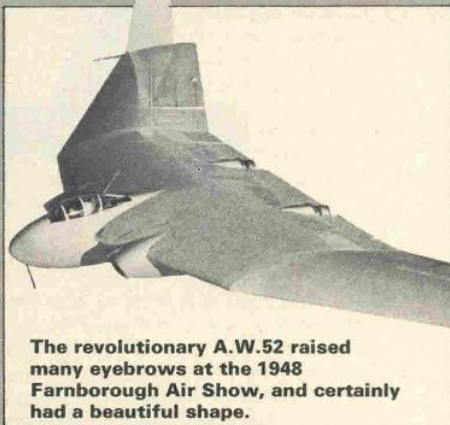
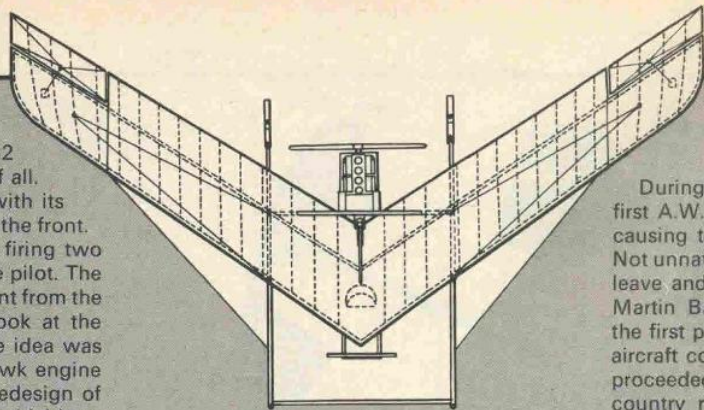
Other more adventurous projects followed in this remarkable series of flying wings, like the twin engine flying boat and the airliner with passengers accommodated in the wing. These however never passed beyond the model stage. If you go along to the Science Museum in London you will see the first powered Pterodactyl, the sole survivor of these early flying wings.

## HIGH SPEED FLIGHT

The important point about these early tailless swept wing aircraft of Hill's is that they pre-empted the design of jet fighters and bombers to follow twenty years later. If the Pterodactyl had been built with stronger wings there is no doubt that a breakthrough into really high speed flight could have been made far earlier, and Prof. Hill was well aware of this.

The dream was realised again in 1942 when the Armstrong Whitworth company at Coventry began looking at the possibilities of the true flying wing. One of the advantages of the idea, apart from the safety and stability angle, is the weight and drag saved by omitting the conventional fuselage and tail surfaces.

Armstrong Whitworth wanted to combine these advantages with those of a laminar flow wing (this is when the airflow flows evenly over a wider surface of the wing without breaking up all over the place and causing lots of drag). The company set their sights on a large-span six-jet passenger aircraft with the engines and passengers housed within the wing. But first they had to make flying scale models to ensure they had got their sums right. The first of these test models was a 54 foot span wooden two-seat glider which was first towed into the air on March 3, 1945.



**The revolutionary A.W.52 raised many eyebrows at the 1948 Farnborough Air Show, and certainly had a beautiful shape.**

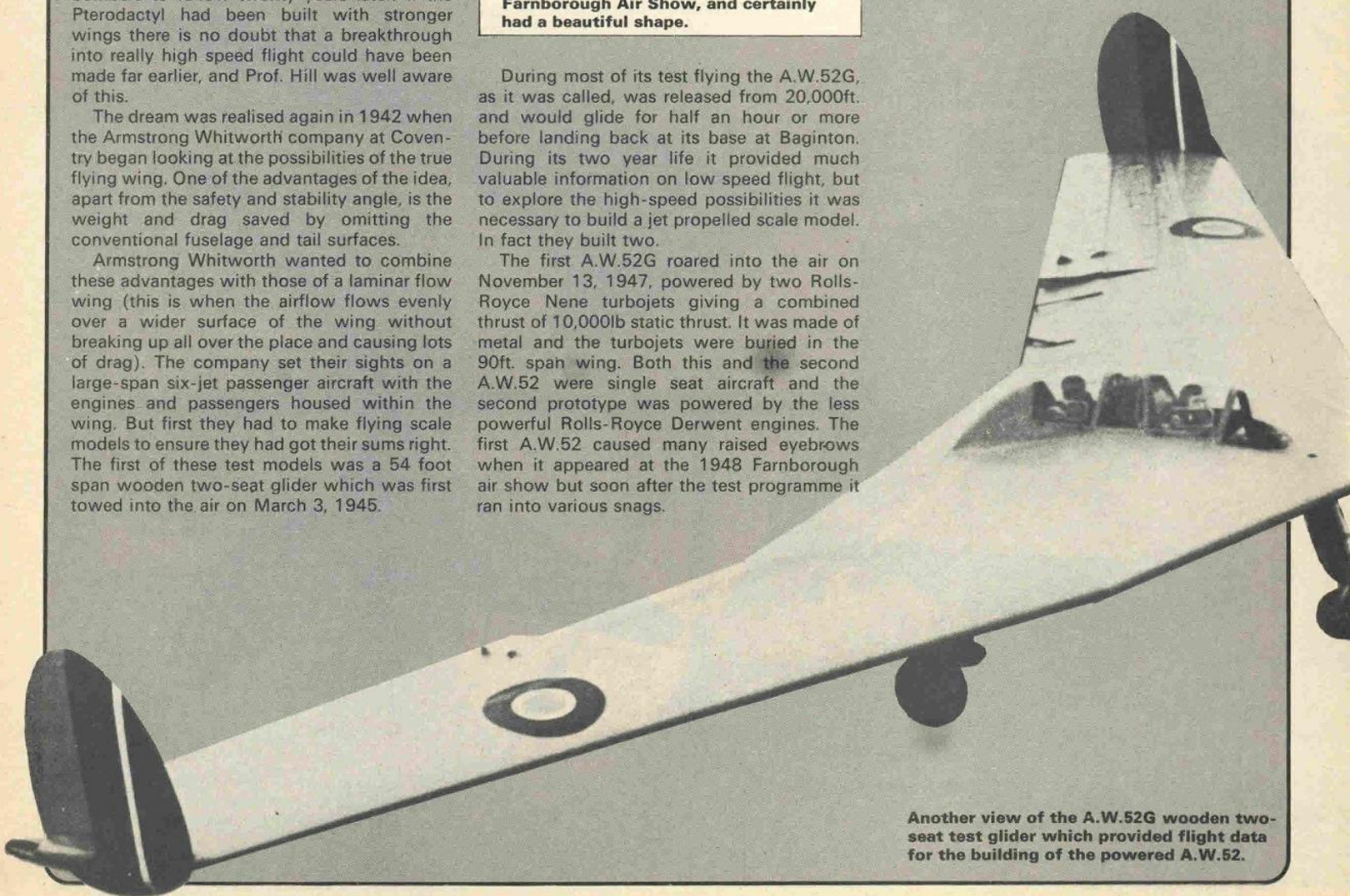
During most of its test flying the A.W.52G, as it was called, was released from 20,000ft. and would glide for half an hour or more before landing back at its base at Baginton. During its two year life it provided much valuable information on low speed flight, but to explore the high-speed possibilities it was necessary to build a jet propelled scale model. In fact they built two.

The first A.W.52G roared into the air on November 13, 1947, powered by two Rolls-Royce Nene turbojets giving a combined thrust of 10,000lb static thrust. It was made of metal and the turbojets were buried in the 90ft. span wing. Both this and the second A.W.52 were single seat aircraft and the second prototype was powered by the less powerful Rolls-Royce Derwent engines. The first A.W.52 caused many raised eyebrows when it appeared at the 1948 Farnborough air show but soon after the test programme it ran into various snags.

During a test flight on May 30, 1949, the first A.W.52 suddenly developed wing flutter causing the entire aircraft to shake violently. Not unnaturally the pilot decided it was time to leave and made history when he took to his Martin Baker ejector-seat, becoming one of the first people to do so in an emergency. His aircraft continued to fly, sorted itself out, and proceeded to glide on and land in open country relatively undamaged, saying much for the stability of the flying wing.

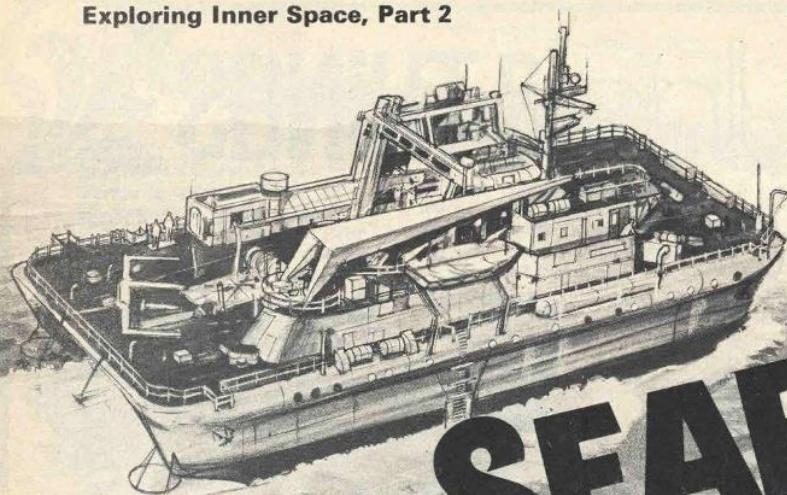
Armstrong Whitworth decided not to press on with the flying wing concept as they were fully occupied with producing a conventional airliner at the time, so they sent the second A.W.52 to the Royal Aircraft Establishment at Farnborough where it was finally scrapped exactly twenty years ago.

Next week we turn to America where, during the 1940s the flying wing almost began to become a reality.



**Another view of the A.W.52G wooden two-seat test glider which provided flight data for the building of the powered A.W.52.**





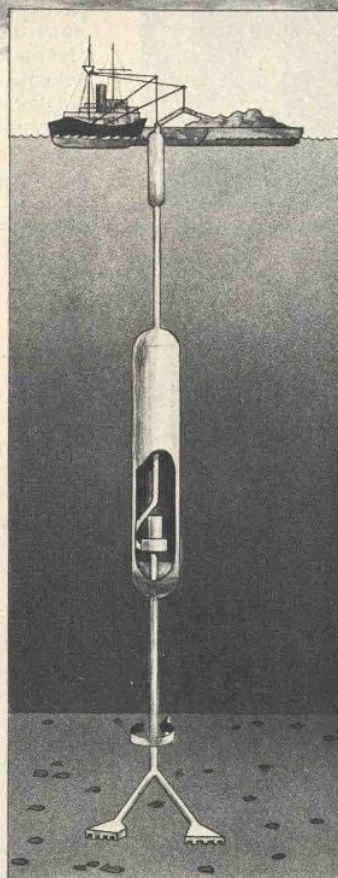
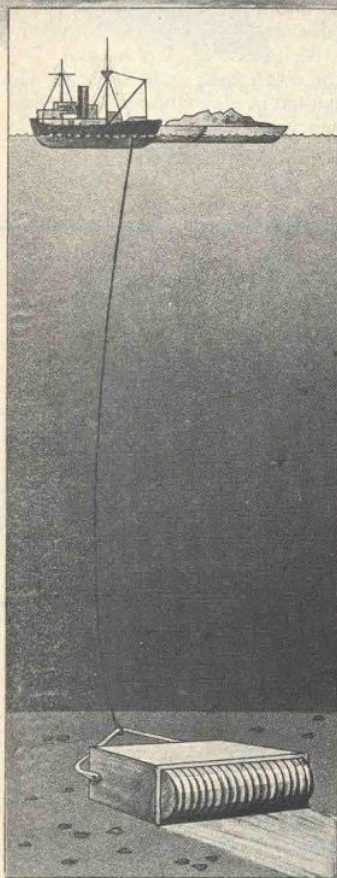
**L**AST WEEK, when we talked about exploring inner space we learned how much there was yet to be discovered in the deep oceans and continental shelves of the world, and took a brief look at the way in which oil is now being recovered from the North Sea and other relatively shallow waters.

This week we are looking at a different system for working in

cerned being subject only to normal atmospheric pressure because, unlike a diver who has to stand up to the enormous pressure of the water as he goes down, he is safely inside the immensely strong diving bell or transfer capsule in which he submerges.

So far, tests of the SEAL systems

# SEARCHING THE SEABED



The picture at the top of the page shows one of many new designs of ships which have been developed to help off-shore drilling activities. It is the catamaran *Duplus*. It is very stable at sea and can be used as a drilling and coring platform, and for surveying the sea floor. The drawings immediately above show two methods which may be used for recovering valuable minerals off the sea floor. Left, an enormous box with prongs could be dragged along by a surface ship. Once the "box" was full it would be hauled to the surface. Another method of gathering modules is shown on the right the material would be sucked to the surface and pumped into a barge.

deeper and rougher waters, and at the recovery of other sorts of minerals which are lying on the sea bed as opposed to being thousands of feet under it.

Strangely enough it is easier to recover the oil and gas which lies under a complicated rock structure—once you have discovered it is there—than it is to recover some of the manganese nodules and other materials which lie on the sea bed just waiting to be picked up.

One such system for just picking up the nodules is estimated to be costing at least £100 million, and even though the money is there the technology for actually carrying out this recovery operation is still a long way from being totally developed. But first let us look at sea bed systems for recovering oil.

Instead of building enormous towers as we described in last week's article, there is much to be said for building a complete structure on the sea bed. Some designs have been proposed by American companies. One is for a complete system on the sea bed, and another shows a processing system in a big hall where men could work in what is called a "shirt-sleeve" environment. Built above this, is a tower which goes up to the surface of the sea.

Another system is called SEAL, in which the British Petroleum Company is involved. Once the oil well has been drilled on the sea bed it is necessary to put in a valve to stop it just gushing out. Normally when this valve is open the oil is fed through a pipeline placed along the sea bed (or buried beneath it), to the shore or to a tanker terminal at sea.

In order that the well-head can be looked after, an enclosure is built around it. Men can go down to this in a separate capsule which is lowered from a ship and can then transfer into the control room and so into the workroom itself.

All this is done with the men con-

have been carried out in the Gulf of Mexico on a real oil well, and it seems very likely that the first working well will be installed somewhere off the British Isles in the next year or two.

Turning to those mineral resources which lie on the bed of the ocean, two ideas have been put forward by Americans for recovering manganese nodules. These nodules are literally lumps of minerals about the size of an egg, or even larger, which are scattered about on the ocean floor, mainly in the Pacific.

One way of recovering them is to use an enormous box with prongs at the back, and drag it over the sea floor using a surface ship, or it could be propelled with its own motors on the sea bottom. The silt and other material comes out through the prongs at the back and the nodules themselves are caught and then brought up to the surface in the dredge.

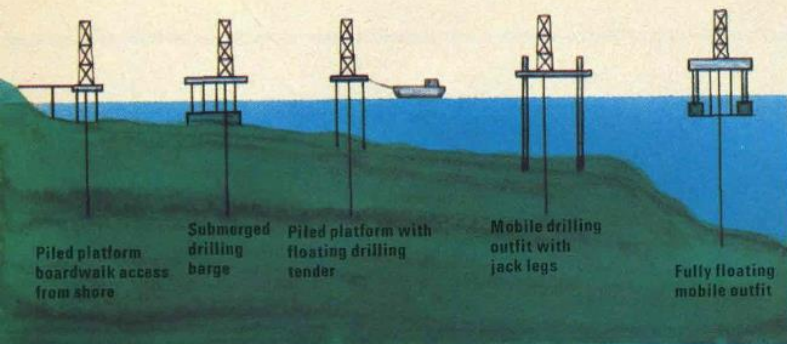
## VACUUM CLEANER

Another system involves using what is really a rather large vacuum cleaner to suck the materials up to the surface ship and transfer them into a large barge. This has a great advantage over the first system in that it can be carried on continuously. With the first system the dredge has to be hauled to the surface through many thousands of feet of water, emptied and then lowered to the bottom again.

The system costing £100 million, which we mentioned earlier, is about to start its trials but these are shrouded in great secrecy. Very little is known about the way in which the system is going to work. But it is thought that a large submersible barge is lowered from the mothership and collects the material on the sea bed.

A number of other schemes exist. One is Japanese, and very recently a British company has joined with an American organisation to develop yet another system for recover-





ing these minerals. By 1980 there will be a shortage of land-based mineral resources and we shall have to turn to those which are in the sea. This really is a technology and an industry which is right at the beginning of its development, and very considerable changes are going to be seen in the next few years.

All these offshore activities require to be supported in terms of materials, men, food, and equipment, and by a whole fleet of ships and many offshore oil areas, it is the humble supply boat which carries out this task. Even these are now very different from the simple support boats which were in use only five years ago.

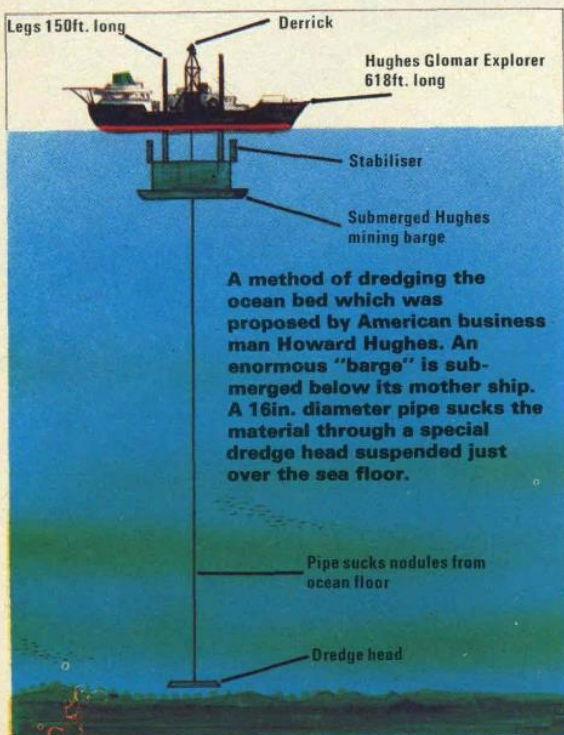
## HOVERCRAFT

Looking into the future we may see further changes. As these areas get further and further offshore it will be necessary to travel more quickly, and to provide more stable vehicles as support vessels. To cover the higher speed requirements hovercraft may be used. But at present hovercraft are unable to deal with the sort of conditions that exist in the open sea.

A greater possibility is the hydrofoil craft. Top speed can be around 60 knots compared with the top speed of 20 to 30 knots of a conventionally hulled ship. The United States Navy has, over a considerable period of time, supported the development of hydrofoils, and although this sort of craft has been used in Britain, on the Thames and elsewhere, it is perhaps in Scandinavia that they are best known for their work in relatively sheltered waters. Here again is an area where further rapid developments are likely.

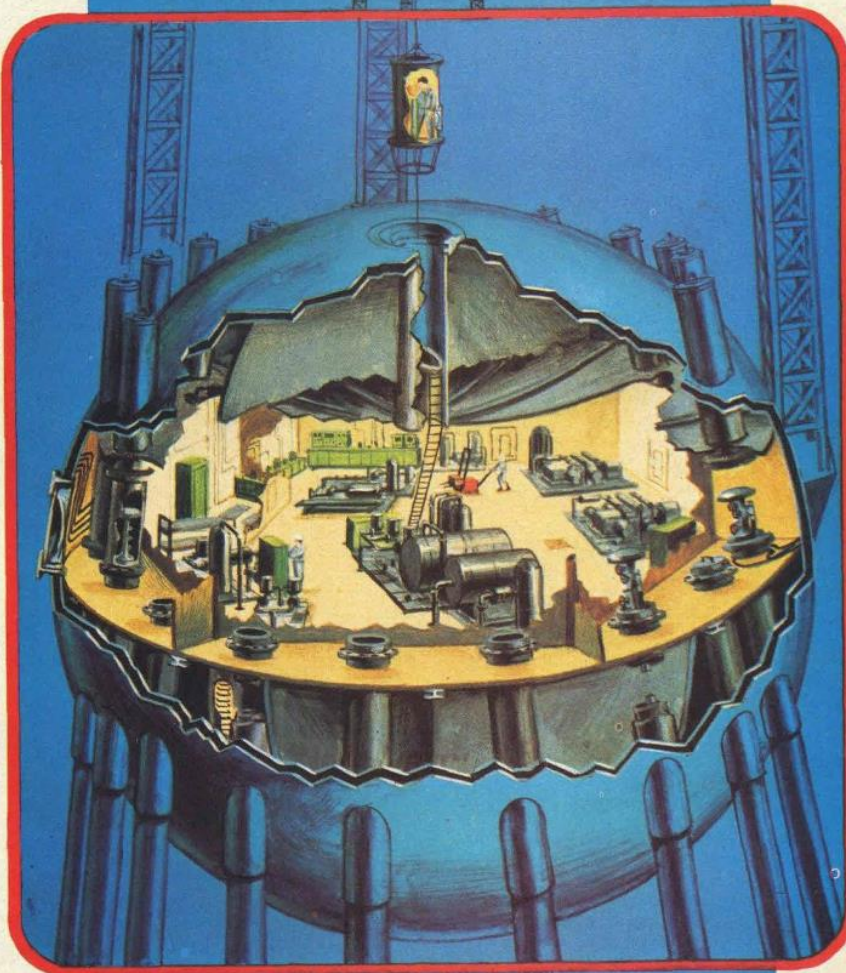
But when proceeding as a ship the hydrofoil craft has no greater stability than a ship. It is then that we may have to consider turning to catamaran (twin-hulled) craft. One in particular is being used by an Anglo-Dutch company for taking samples of the sea bed. In the same way that sailing boats with twin-hulls stay upright in rough conditions, so do these twin-hulled working catamarans.

There are very many problems which have still to be solved in ocean exploration and using the ocean's resources. All of them must be solved if we are to go on with our way of life as we know it.



A method of dredging the ocean bed which was proposed by American business man Howard Hughes. An enormous "barge" is submerged below its mother ship. A 16in. diameter pipe sucks the material through a special dredge head suspended just over the sea floor.

The picture on the left shows different types of oil rigs, some resting on the sea bed, and others anchored in position in deep water. The large illustration below shows an American idea for building a complete mining complex on the sea bed. The men working in the enormous sphere can remain in an environment similar to that on the surface.





# Speed

## & Power

10p Weekly  
No. 17. July 12-19, 1974

**YEAR OF THE  
LIFE-BOAT**



**INDY 500**



**SHIPS SPACE  
CARS PLANES  
SCIENCE FICTION**



**T**HIS WEEK we are concentrating on the work of one company, the Northrop company of America. In 1928 John K. Northrop began investigating the possibilities of all-wing aircraft although his first venture into that field was a twin-boomed aircraft with a very thick wing section accommodating the pilot and passenger. It was small, with a 30½ foot wing span, and was powered by a 90hp engine. It behaved well in the air and the next logical step would have been to remove the nominal twin boom carrying the tail but Northrop was prevented from doing this for financial reasons.

The following year he formed the company that bears his name to this day and for the first few years busied himself with the design and production of conventional aircraft. During this time however he was working out all-wing designs on paper

and visualising flying wing bombers for the future. His sums convinced him that an all-wing aircraft would be lighter than conventional aircraft and could carry the same load farther on the same amount of fuel and at the same cruising speed.

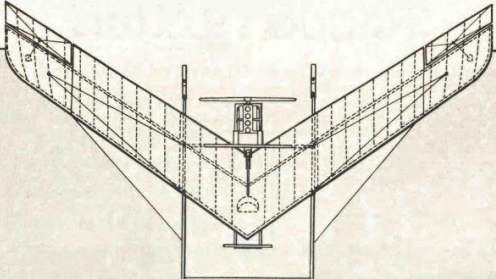
In 1939, he built a full size mock-up flying wing, the first all-wing aircraft in the world. Of course the whole programme was shrouded in great secrecy and the bright yellow wing with its tips cranked down was completed in 1940.

Its strange appearance earned it the nickname, "ruptured weather-racked duck", but its designers preferred to call it the N-1M. It was powered by two 65hp pusher engines and made a tentative first flight in July 1940. The test pilot held the aircraft close to the ground during this flight, because, it was said, "to make the crash a bit easier."! But the revolutionary aircraft flew well and completed a test programme of some 200 flights, later flying with more powerful engines.

With the valuable practical information provided by this first research flying wing it was time to produce flying scale models of the bombers that Northrop were visualising. Four were built and they were one third size of the great bombers to come, with a wing span of 60 feet.

The first of these took off in December 1942 but after a few encouraging flights crashed early

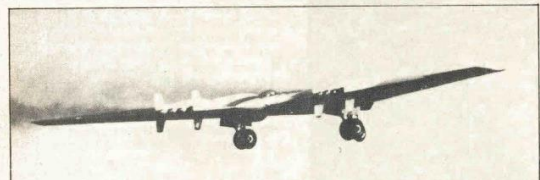
Concluding our series on the history of flying wings, strange, futuristic-looking aircraft whose designs and performance were way ahead of their time



# ALL-WING BOMBERS

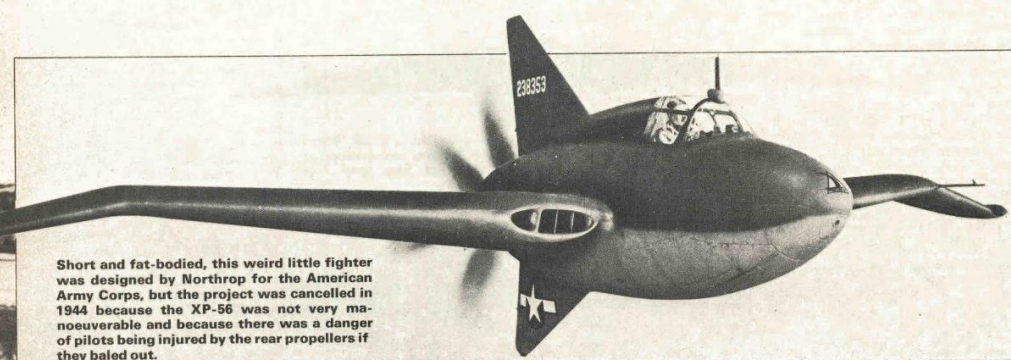
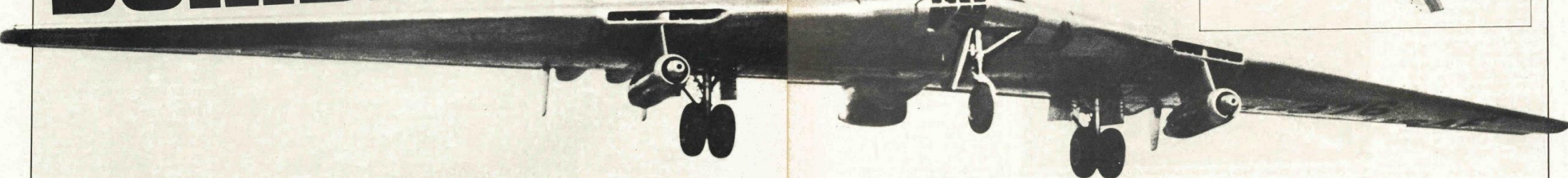
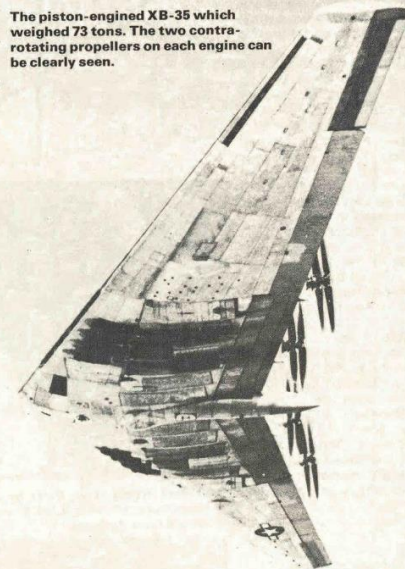


The first all-wing aircraft in the world, the Northrop N-1M which flew in 1940. Its strange appearance earned it the nickname "ruptured weather-racked duck"! It was powered by two 65hp engines.



One of the last Northrop flying wings, the jet-powered YB-49 bomber which could fly at 400mph with a range of 5,400 miles, a phenomenal performance for an aircraft of the early 1950s.

The piston-engined XB-35 which weighed 73 tons. The two contra-rotating propellers on each engine can be clearly seen.



Short and fat-bodied, this weird little fighter was designed by Northrop for the American Army Corps, but the project was cancelled in 1944 because the XP-56 was not very manoeuvrable and because there was a danger of pilots being injured by the rear propellers if they baled out.



in the programme killing the test pilot. The reason for the crash was never determined but test flying continued with the other three and the outcome of the programme was proof to its critics that the flying wing was sound.

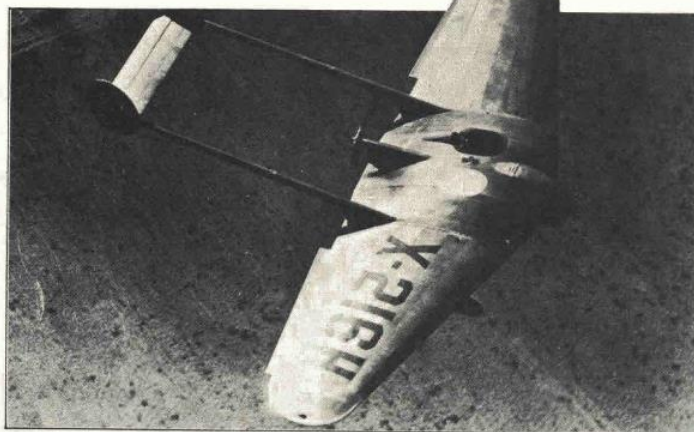
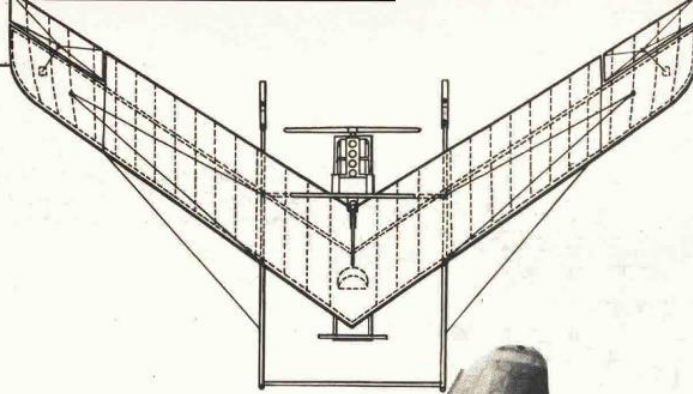
During this time Northrop had been working on a weird looking fighter for the American Army Air Corps. The Corps was wary of an all-wing design and so Northrop had to design a short, fat-bodied twin-engined pusher that was almost, but not quite, a flying wing. It was not adopted by the Corps because they thought it was not manoeuvrable enough and didn't match its many competitors, which at that time looked just as weird as the XP-56. So the fighter idea was dropped although it could well have been one of the fastest piston engined aircraft of all time.

Meanwhile there followed other research aircraft including a glider flown by a pilot lying down and a rocket powered flying wing produced to pave the way for future jet powered flying wings. It first flew on July 5, 1944 when it was towed to sufficient altitude behind a Lockheed Lightning fighter. The pilot then cast off and pressed the trigger to start the rocket motor. It was a most successful flight during which the pilot dived to 350mph and pulled up vertically for 6,000ft, much to the amazement of onlookers.

Northrop then buckled down to produce their massive bombers. They had most of the information they required and on paper it looked as though the flying wing bomber would score over the current bombers in production up to that time. It was designated the XB-35 and was powered by four of the most powerful piston engines available at that time, a combined 14,000hp in all. Work started on the prototype in early 1943 but it wasn't until June 1946 that it was ready to fly and astound the world.

Fully loaded the XB-35 weighed over 73 tons. It had a crew of 15—pilot, co-pilot, bombardier, navigator, engineer, radio operator, and three gunners. It could also carry six additional crew asleep on folding bunks, necessary with an aircraft having a potential range of 10,000 miles. One innovation was the installation of crash proof petrol tanks.

During testing the XB-35 had terrible propeller problems. It was originally fitted with enormous eight-bladed contra-rotating propellers, four turning one way and four the other, but these were



**The first flying wing built by John K. Northrop was really a twin-boomed aircraft with a thick wing. Built in 1928 it was the forerunner of all his later designs.**



**Like some alien craft flying over a lunar landscape, the jet-powered Northrop makes a test flight over the Californian desert. It out-classed all its contemporaries with its short take-offs and astounding rate of climb.**



**A head-on view of the YB-49 sweeping low over the runway. This version had eight jet engines buried in its huge 172 foot span wing. A later version, the YRB-49A, (centre, pages 4-5) had six more powerful engines, two of them mounted in pods under the wing.**

later dropped in favour of large square-tipped four-bladed propellers, although the resulting noise was enormous. These propulsion problems delayed the programme by two years and in the meantime an order for 200 B-35s had been cancelled.

The obvious progression to the XB-35 was a jet version and this occurred during 1946-47. It was designated the YB-49 and was a competitor with Convair's B-36. It was an absolute winner and it out classed all its contemporaries with its short take-offs, astounding steep climbs and superior range. As before the entire programme was carried out under strict secrecy and even today the full potential of the YB-49 is not clear. It has been estimated that it would cruise at 400mph at about 47,000 ft. and that its disposable load was made up of 40 tons of fuel and 13 tons of bombs with a range of 5,400 miles. It was powered by eight 4,000lb thrust jets and with the same wing span as the earlier XB-35 it had an all-up weight of 95 tons.

Once again earlier in the YB-49 programme there were reports of large orders for the revolutionary aircraft, some estimates as high as 500. But the Air Force had cut down dramatically on expenditure and put all their eggs in the Convair basket. About 15 B-35 airframes were built finally.

The only light on the horizon for Northrop was the go ahead for a new six-jet flying wing reconnaissance aircraft. It was the intention that the remaining XB-35 airframes should be converted to the jet YB-49 style but this programme was also cancelled after only one aircraft had been converted.

The new YRB-49 first flew on May 5, 1950—and had two jets slung under the wing and the other four buried inside the wing. It was an impressive sight during take-off and could fly at 500mph, was capable of non-stop range of 9,000 miles—and had an all-up weight of 92 tons.

But the writing was on the wall and the flying wing dream came to nothing. As a final gesture the only surviving YB-49 made a

really astounding flight which averaged well over 100mph faster than Convair's B-36 and at one stage flew 3,458 miles at 382mph with a simulated full bomb load. With more imaginative thinking the flying wing might have been a reality today, but now the Lockheed Company have revived the dream with their giant Spanloader shown in Part 1 of this series.



# SPACE IS FOR EVERYONE

**A**merican astronauts have so far logged 21,893 hours in space. That's equal to one man living in space for about 2½ years. The first mission, on May 5, 1961, lasted 15 minutes. The latest to be completed, Skylab-3, went on for more than 84 days. Twenty-four astronauts have flown to the moon and back. Twelve of these have spent a total of almost 220 hours on the surface of the moon. The total number of US manned missions now stands at 30.

What has all this taught us about Man's ability to probe farther into space, and to carry out useful work there?

One man who should know is Dr. Charles Berry, who was for 15 years the astronauts' family doctor. Dr. Berry is also a pioneer of space medicine with a reputation which has brought him fame throughout the world. He helped to choose the 73 astronauts who were first selected for training. He was also responsible for maintaining their health, both before and after flights.

When Dr. Berry joined NASA, way back in 1958, a fierce debate was raging among space scientists and doctors. It centred around questions like, "Can man really stand the rigours of space flight?" and "Will he be able to survive in strange and hostile conditions that no one has experienced on Earth?"

## SEVERE INJURIES

Some experts thought that the crushing g-forces of lift-off and re-entry would severely injure the frail human frame. Others predicted that the state of weightlessness would create frightful problems, and make sleeping, eating and other bodily functions virtually impossible. Then there were the known perils of exposure to radiation, and the fear that orbiting spacecraft would quickly be punctured by flying space debris. There was only one way to find out...

So the early astronauts were in a real sense guinea pigs, reaching out into an unknown world full of real or imagined dangers. No wonder the world acknowledged them as the supermen of their day. Every conceivable precaution was taken, of course. Scientists and engineers dreamed up ingenious ways to simulate space conditions on Earth, and the astronauts were put through the most rigorous training. The early space missions were short, and the time that the spacemen were exposed to space dangers was increased very gradually. It was a step-by-step approach, with the lessons of each mission being applied to the next.

## REGULAR SERVICE

The six missions of the Mercury programme were successfully completed, and the 12-mission Gemini programme got underway, with regular launchings scheduled every three months. It was already becoming clear that the dire predictions of disaster were at least exaggerated.

By the end of 1965, Dr. Berry and the other space planners were pretty confident that men could survive in space for a couple of weeks. The Gemini-7 mission, in which astronauts Frank Borman and Jim Lovell lived for a fortnight in a capsule not much bigger than the front half of a family car, proved their theory and was a landmark in the serious game of space survival.

More recently the Skylab space station has provided more important evidence—that a long stay in space is probably less dangerous than a short one.

## MARATHON MISSION

The third Skylab crew was apparently in better shape after their marathon 84-day mission than the two earlier Skylab crews, who had orbited the Earth for 28 days and 59 days respectively, and had broken existing endurance records at the time of their flights. Right from the beginning of space flight, some astronauts have suffered from nausea and dizziness, a condition known as space sickness. But this is a temporary discomfort. A more serious aspect of space flight is that the human body adapts to a gravity-free environment, gets used to shrink-lessness. Muscles tend to shrink. The heart, freed from the burden of pumping blood against the pull of gravity, works less strenuously. And changes take place in the blood and in body chemistry. But the astronauts soon recover when they return to Earth.

## BODY BALANCE

The third Skylab crew adapted more readily than any other astronauts to the weightless environment, which indicates to doctors that there is a plateau point, probably round about 50 days, when the body regains its balance and its systems start to function very much as they would at ground level.

This in turn suggests that men may be able to live and work in

space indefinitely. Dr. Berry thinks there is now no medical reason why astronauts should not travel to Mars and back on journeys lasting up to two years. They might tackle even longer journeys once the vehicles to transport them become available.

Other experts are confident that the human body can adapt well enough to space conditions for the average healthy person to withstand the rigours of space flight. The Skylab medical director said recently: "I don't think we've found anything that Man can't endure." With the space shuttle due to make regular trips in the 1980s this is exciting news.

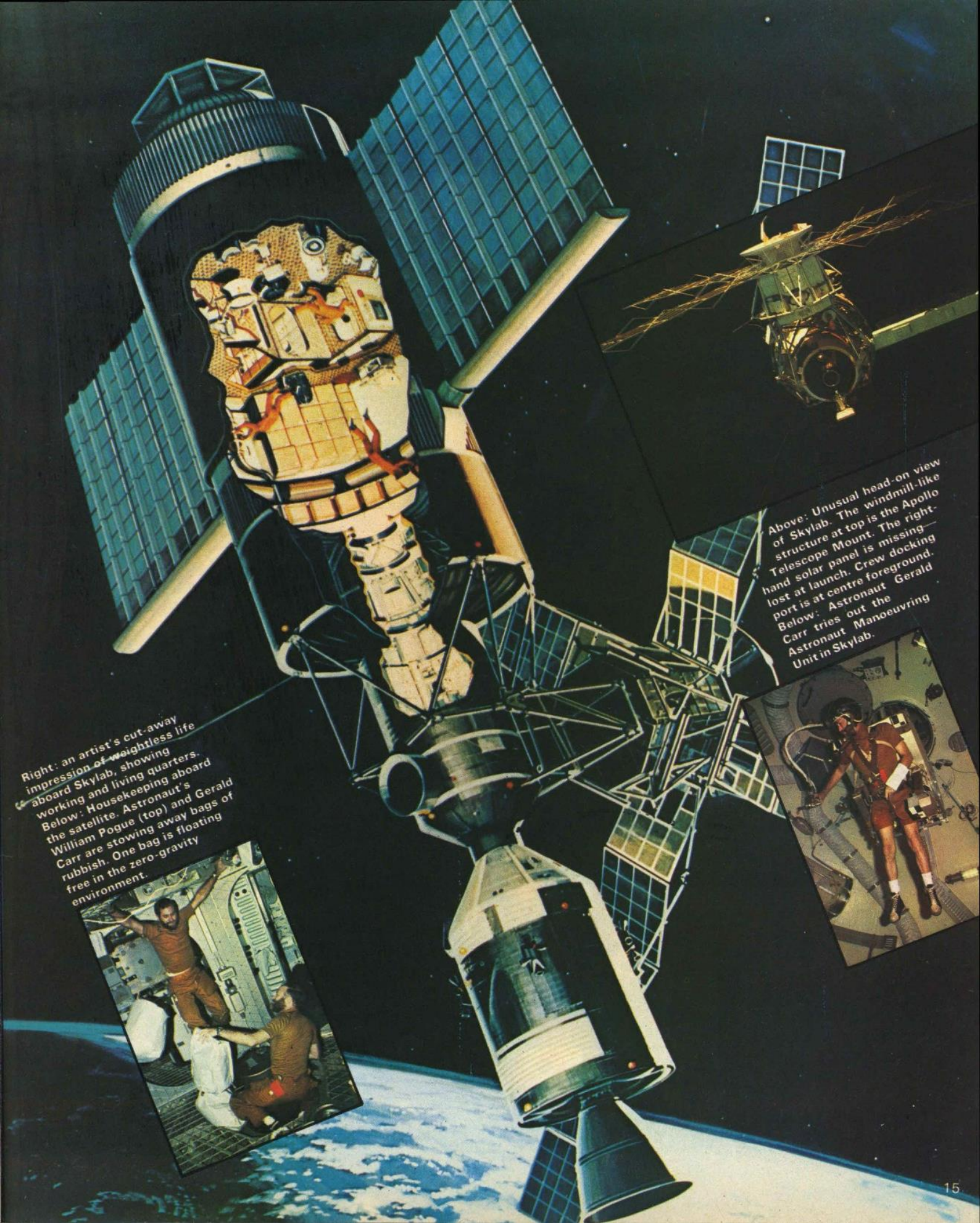
Skylab's success could also revive interest in the idea of a permanent space station in Earth orbit, assembled in space from parts taken up by the shuttle, and manned by rotating crews.

**Far left: the first three Skylab astronauts (L. to R., Weitz, Conrad and Kerwin) in front of the Saturn V rocket which sent their space station into Earth orbit from Kennedy Space Centre, Florida. Left: Dr. Charles R. Berry, famous the world over as "the astronaut's family doctor".**

photos: courtesy of NASA







Right: an artist's cut-away impression of weightless life aboard Skylab, showing working and living quarters. Below: Housekeeping aboard the satellite. Astronaut's William Pogue (top) and Gerald Carr are stowing away bags of rubbish. One bag is floating free in the zero-gravity environment.



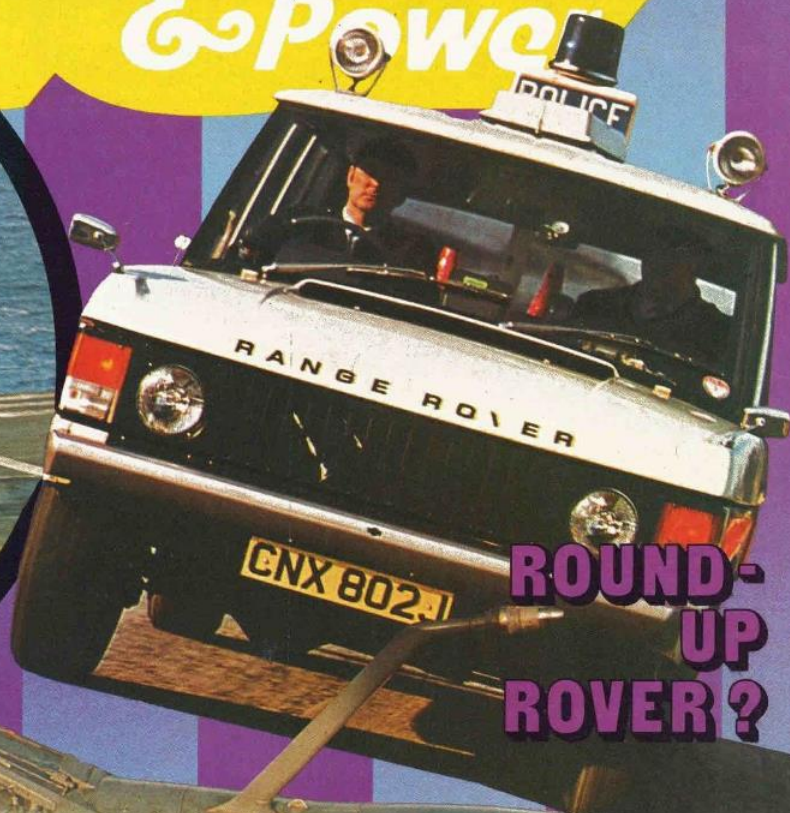
Above: Unusual head-on view of Skylab. The windmill-like structure at top is the Apollo Telescope Mount. The right-hand solar panel is missing—lost at launch. Crew docking port is at centre foreground. Below: Astronaut Gerald Carr tries out the Astronaut Manoeuvring Unit in Skylab.





# Speed & Power

10p Weekly No. 19  
July 26 — August 2, 1974



**ROUND-  
UP  
ROVER?**



**WINGS ABOVE  
THE WAVES**

**PLANES CARS SHIPS TRAINS SCIENCE FICTION**



# Under the sea -by rail-at 100mph

**P** LATFORM 3 for the 0810 Inter-City service from Manchester and Birmingham going forward to Brussels and Cologne".

"Passengers for the 0800 Trans European Express from London to Paris proceed to Platform 1".

By 1981, announcements like these will greet passengers arriving at the newly opened White City station in London on their way to Europe by train through the Channel Tunnel.

Let us go forward in time to that year and join a train about to make an exciting trip to Paris, along the first main line railway to be built in Britain for 80 years. It is about to speed down to Folkestone and then plunge under the English Channel at 100mph, through the 32 miles of the world's second longest tunnel.

At the head of our train waits a giant 8,000 horsepower French electric locomotive. Sitting

at the controls the English driver who will take the train through the Tunnel.

Climbing into the luxurious air conditioned coaches, which are wider and taller than the usual British vehicles, we find the seats that have been automatically reserved for us by a computer as we purchased our tickets. Within minutes the signals clear and the train glides out past the BBC Television Centre and accelerates down towards the first tunnel which takes us under the River Thames to emerge, 11 miles later, clear of London.

As we pass 150 feet under Clapham Junction, still the world's busiest railway junction, the loudspeakers in the coach come to life. They tell us, in English and French, that breakfast will be served shortly and request that we have our passports ready for inspection by the Customs Officers who are travelling on the train.

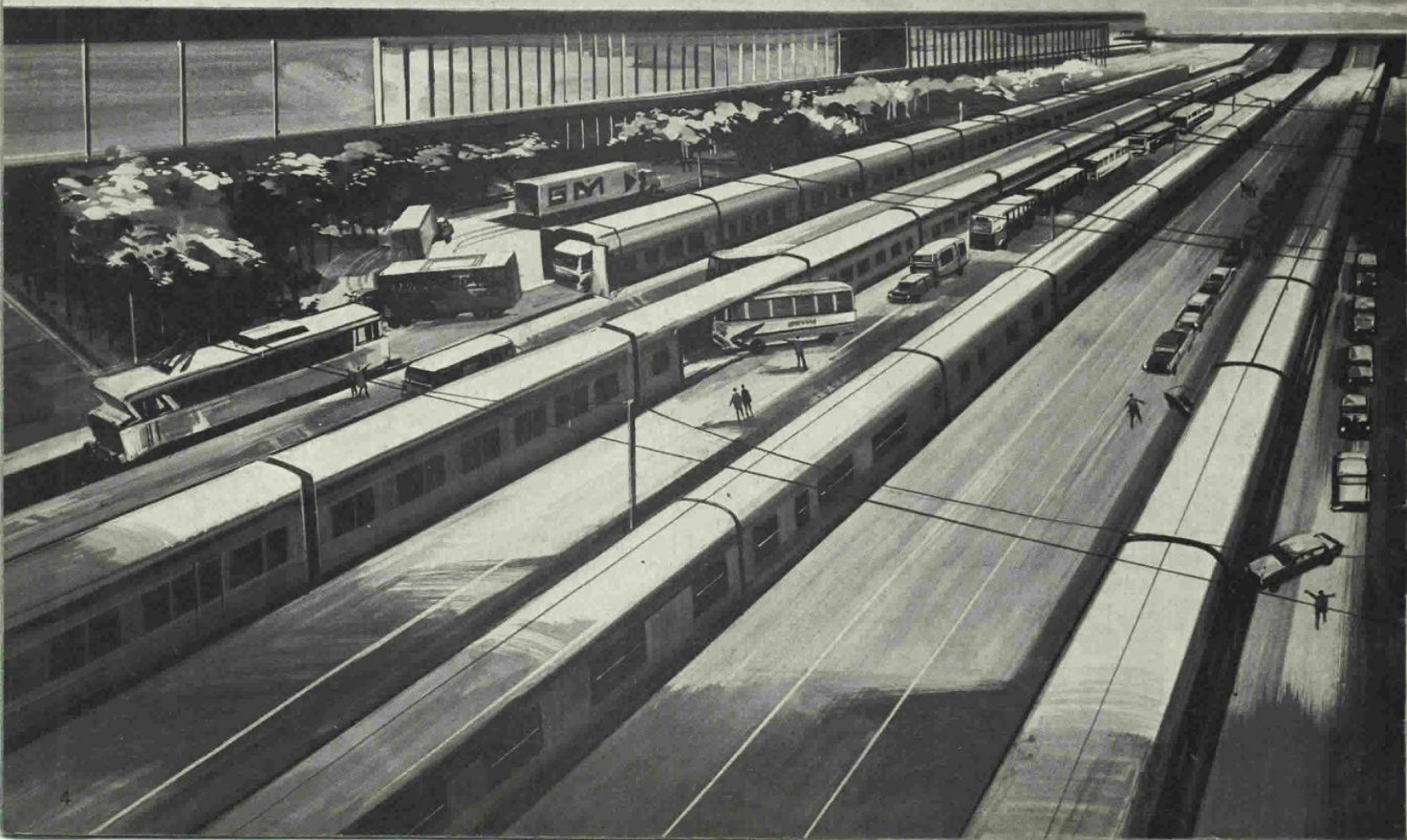
Coming up into the daylight, the locomotive takes maximum power from the 25,000 volt overhead electric wire to accelerate to 150mph

for the dash along the new 60-mile London/Channel Tunnel High Speed Link line. Every few minutes the northbound trains from the Tunnel pass by; Freightliner trains bringing goods from Italy and Switzerland, Motorail trains carrying holidaymakers and their cars back from tours of Spain and Southern France.

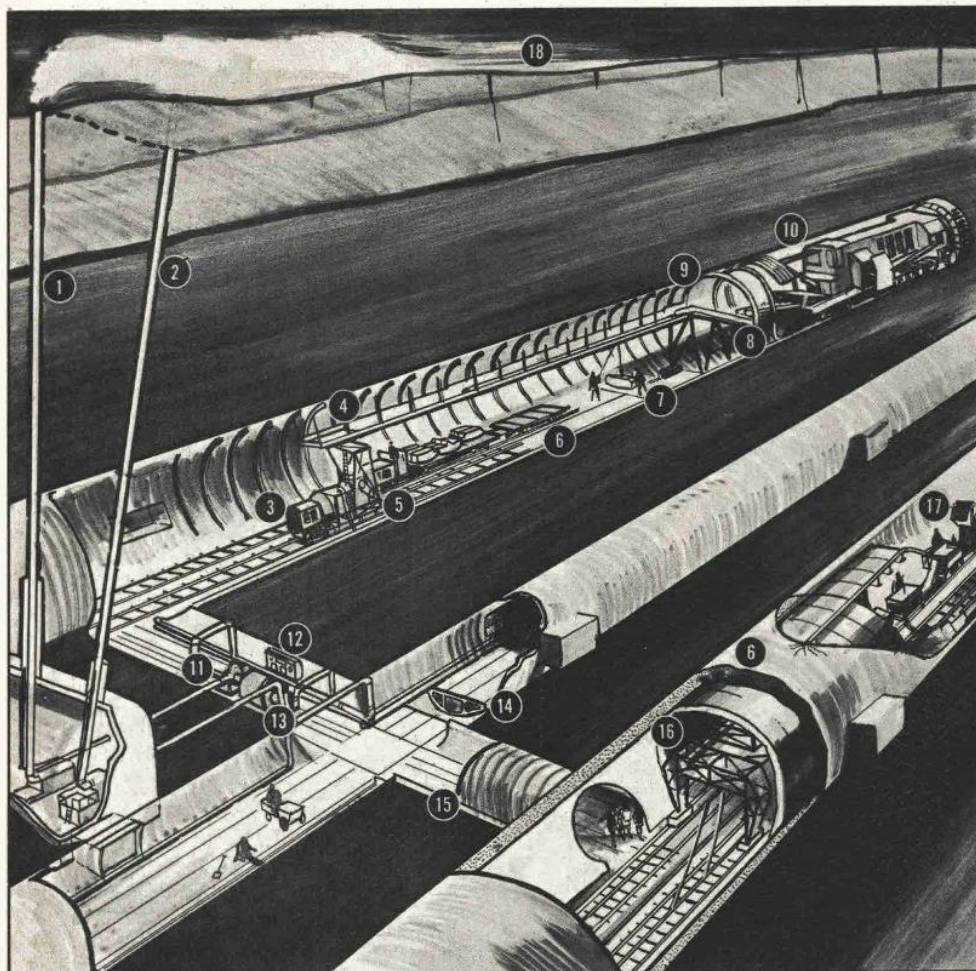
Racing past Ashford we can see the engineering works of British Rail, built to make steam locomotives for the Southern Railway and now making giant 'ferry' vehicles used to operate the merry-go-round services that take cars and lorries for the short trip through the Tunnel before they drive off onto the French motorways.

With a slight hiss from the air brakes the train slows for a signal check caused by a train movement in the ferry terminal at Cheriton. This road/rail interchange feeds traffic off the motorway through Customs and onto the special enclosed ferry wagons for the 35-minute trip through the Tunnel to a similar terminal at Sangatte in Northern France.

**An artist's impression of one of the Channel Tunnel terminals where cars and passengers will board their trains.**







Left: A cut-away drawing of the Channel Tunnel as it will look during construction. KEY: (1) Slurry disposal pipe. (2) Sea water inlet pipe. (3) Low pressure pump. (4) Conveyor belt for waste. (5) Crusher and mixer. (6) Main tunnel. (7) Laying concrete sections. (8) Elevator for waste. (9) Arch ribs. (10) Boring machine. (11) Pump for slurry waste. (12) Motor and controls. (13) Turbine. (14) Service tunnel. (15) Tunnel link. (16) Traveling gantry. (17) Concrete mixer and layer. (18) Sea bed.

Passing the terminal on the through line we can see the long lines of cars and lorries entering the side doors of the ferry wagons, and drivers and passengers settling down in their vehicles for the journey. In the summer rush hours a train can be ready to leave every 6 minutes! And special double-deck wagons will be used to make up trains to carry 270 cars.

Our train slows down to the 100mph speed limit through the Tunnel, and a glance from the window just before we enter the Tunnel gives us a glimpse of the blue waters of the Channel and the White Cliffs of Dover before we descend to rush under the world's busiest shipping lane.

During the actual Tunnel passage there is nothing to see from the windows, but refreshments and magazines are handed out by smartly dressed train hostesses. We are also given information sheets about the Tunnel.

The first suggestion for a Channel Tunnel was made by a Frenchman to Napoleon over 180 years ago. His idea was to use the Tunnel

**CONTINUED ON NEXT PAGE**



Right: A British 5,000 horse-power electric locomotive speeds through the Tunnel, far below the English Channel. It is hauling a train of special ferry wagons carrying people, cars and lorries.



A powerful excavator grinds forward, establishing a service tunnel to where the main 32-mile Channel Tunnel will begin.



to invade England and it was 1964 before the threat of invasion was to be no longer used as an argument against building the Tunnel.

Various schemes were proposed later, as well as a number of bridges, although most people accepted that a bridge in the Channel was likely to be run into by ships very regularly!

## EASY TUNNEL DIGGING

Surveys between 1865 and 1875 showed that the Channel is shallow—only 180 feet at the deepest point and that the sea bed was of chalk, the lowest layer being waterproof yet fairly soft to cut—the easiest material for tunnel digging.

A number of tunnels were started on both sides including one in 1880 which used a mechanical boring machine designed by Col. Beaumont, and which is thought to be the first mechanically bored tunnel in the world. The longest tunnel extended  $1\frac{1}{2}$  miles, far short of its target!

In 1966 the British and French Governments agreed that a railway tunnel should be built. Studies ruled out a road tunnel because of the ventilation problems.

Following a further series of studies the design became clear. It consists of three separate tunnels, two single line main tunnels for the trains with a central service tunnel between and below them (see diagrams). The smaller service tunnel provides access for men and equipment for maintenance, acts as a refuge for passengers in case of accident in the

main tunnels, serves as a ventilation duct, and as a route for cables and pipes.

Safety precautions include the cross connecting of the tunnels every 800 yards so that trains can be diverted around obstructions or passengers transferred. Each train driver has a telephone link to Tunnel Control, and the very latest signalling and fire detection equipment keeps constant watch over the trains which can be as often as one every  $2\frac{1}{2}$  minutes.

But that was a look to the future—today construction has only just begun. The Tunnel

will be bored using mechanical boring machines and lined with concrete or steel rings. The machines move forward about three yards an hour and, with construction from both sides meeting in the middle, work should take five years.

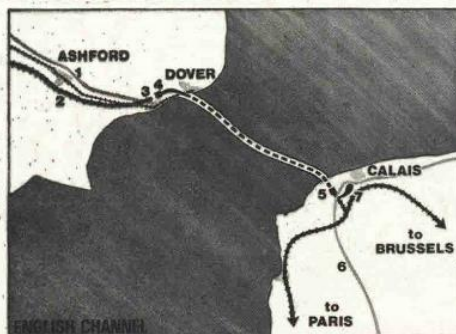
In 1973 it was estimated that the cost of the work would be £900m. The Tunnel will be able to cope with 3,000 cars each hour—equal to the capacity of a three-lane motorway.

Returning to our imaginary journey in 1981, some 25 minutes and 33 miles after entering the Tunnel we shoot out into the open French countryside. Then through the ferry terminal where the trains are loading up for England, past the giant marshalling yard where the freight trains are being sorted out as they arrive from all over Europe into trains for destinations like Cardiff, Sheffield, Newcastle and Glasgow, and off along another high speed link line straight to the heart of Paris.

In 1981 the journey is expected to take 3 hours 40 minutes. By 1990 very high speed trains are expected to bring London and Paris within  $2\frac{1}{2}$  hours of each other, and every other main European city will be within easy reach through the Tunnel.

**The proposed route of the Channel Tunnel or "Chunnel" as it has become known.**

**KEY: (1) M20 Motorway. (2) New high-speed link railways. (3) British Tunnel Terminal. (4 & 5) Tunnel Entrances. (6) A26 Motorway. (7) French Tunnel Terminal.**







An artist's impression of a twin fuselage  
airliner (or is it airliners?) just after take-off.  
The wing is kept at right-angles at low  
speeds and then slowly pivoted back as  
speed increases.

# A NEW SLANT ON WINGS

Plans are under way for aircraft that take the  
swing-wing idea one step further—planes  
where the whole wing pivots,  
and even planes with two  
swinging fuselages!  
Read about them on  
the next page.



**Y**OU PROBABLY have heard about the swing wing, the aeroplane wing that is pivoted on each side of the fuselage so that it can be extended out sideways to give good lift at take-off and landing, and folded back for flight at supersonic speed. Though rather startling when it was introduced a few years ago, the idea was originated by birds! In any case a swing-wing aircraft never looks unusual; the only remarkable thing about it is that it can change its shape from one familiar form to another one.

But now aircraft designers are working on a kind of wing that, though basically simpler, is *really* odd—and nothing like the birds at all! For take-off, the wing is spread out at right angles on each side, just as in propeller-driven aircraft. Where it differs from every previous aeroplane wing is that the wing is made as a one-piece

swing wing, with a pivot at the middle. As the aircraft goes faster, the wing gradually pivots round, so that on one side it is sloping forwards and on the other side sloping back. It is the oddest thing anyone could imagine. In fact it brings to mind a model glider or rubber-driven aircraft which has made a crash landing and knocked its wing askew!

### CRAZY IDEA

These new machines will be called oblique-wing or slew-wing aircraft. Nearly all those being planned are civil airliners. Not one has yet been built, but the idea—crazy as it looks—makes a lot of sense. It is quite likely that, eventually, it will become the normal way of making most jet airliners. But before that happens many thousands of men must spend years working with computers



The military role of the oblique wing aircraft is shown in this artist's impression of two fighters. This idea was originated by the German Blohm Und Voss Company, but unfortunately never got past the drawing board stage. It is, nevertheless, still a possibility for the future. The way the wing turns is clearly shown.

and other research tools to find out exactly how such strange aircraft can best be designed.

Why does the oblique wing make sense? The basic reason is that wings are better when stretched out sideways at low speeds and folded back at high speeds. The oblique wing seems to do this better than the ordinary swing-wing. In many ways it is simpler; the wing needs only one pivot, and the pivot does not have to bear any of the heavy bending loads but merely supports the aircraft fuselage. Another factor is that, at speeds just above the speed of sound—Mach 1.2, or 20

per cent faster than sound, is about the fastest you can go at high altitude without making a sonic boom on the ground below—the oblique wing gives more lift for less drag (air resistance) than other wings.

### FIVE STUDIES

The world's biggest builder of jetliners, the Boeing Company, recently made detailed calculations of five different kinds of jetliner to carry a load of about 20 tons at Mach 1.2 over a distance of 3,450 miles. They found that the ordinary kind of swing-wing aircraft came

out easily the heaviest, with a laden weight of more than 400 tons. In contrast, the oblique wing design came out the lightest, with a total weight of not much more than 200 tons. The oblique wing had less drag, and so would burn less fuel, and thus promised to be by far the cheapest aircraft to run.

There was a second type of oblique-wing aircraft in this study, though it did not come out quite

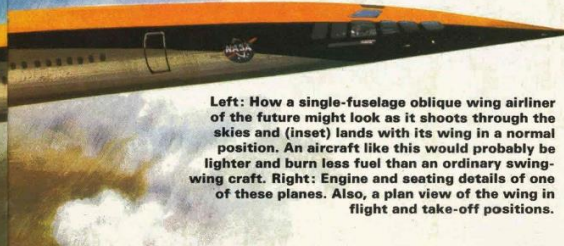
so well. This looks even stranger, because it has two fuselages, side-by-side, with the wing pivoted to both of them. Thus, as the wing is pivoted round, one fuselage overtakes the other! So the people looking out will see different faces opposite them in the other fuselage until the wing has taken up its full sweep angle of perhaps 50 degrees. One can wonder how many sets of pilots

there ought to be; two—one in each nose, or just one (preferably in the fuselage that sticks out in front)?

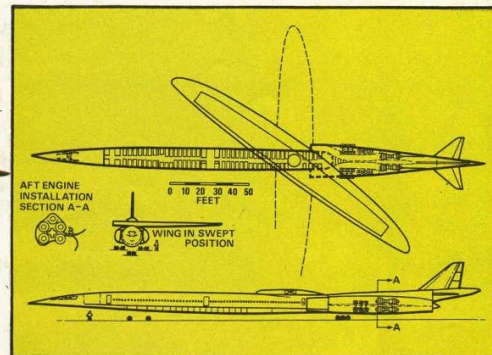
There are still plenty of other problems, too. These centre around the way the forward-pointing wing flies through the air. If you try to run pulling a sheet of hardboard edge-on like a wing behind you there will be no problem, but if you try to push it in front of you it

will be very difficult to control. The forward-pointing wing must be made very strong and stiff. Surprisingly, though, there seem to be few problems in controlling the aircraft or getting its balance right.

The oblique-wing aircraft is the sort of thing that looks mad, and perhaps 20 years ago it would have been laughed at. But, it seems to be better for the 800mph jetliner than any other sort of wing.



Left: How a single-fuselage oblique wing airliner of the future might look as it shoots through the skies and (inset) lands with its wing in a normal position. An aircraft like this would probably be lighter and burn less fuel than an ordinary swing-wing craft. Right: Engine and seating details of one of these planes. Also, a plan view of the wing in flight and take-off positions.





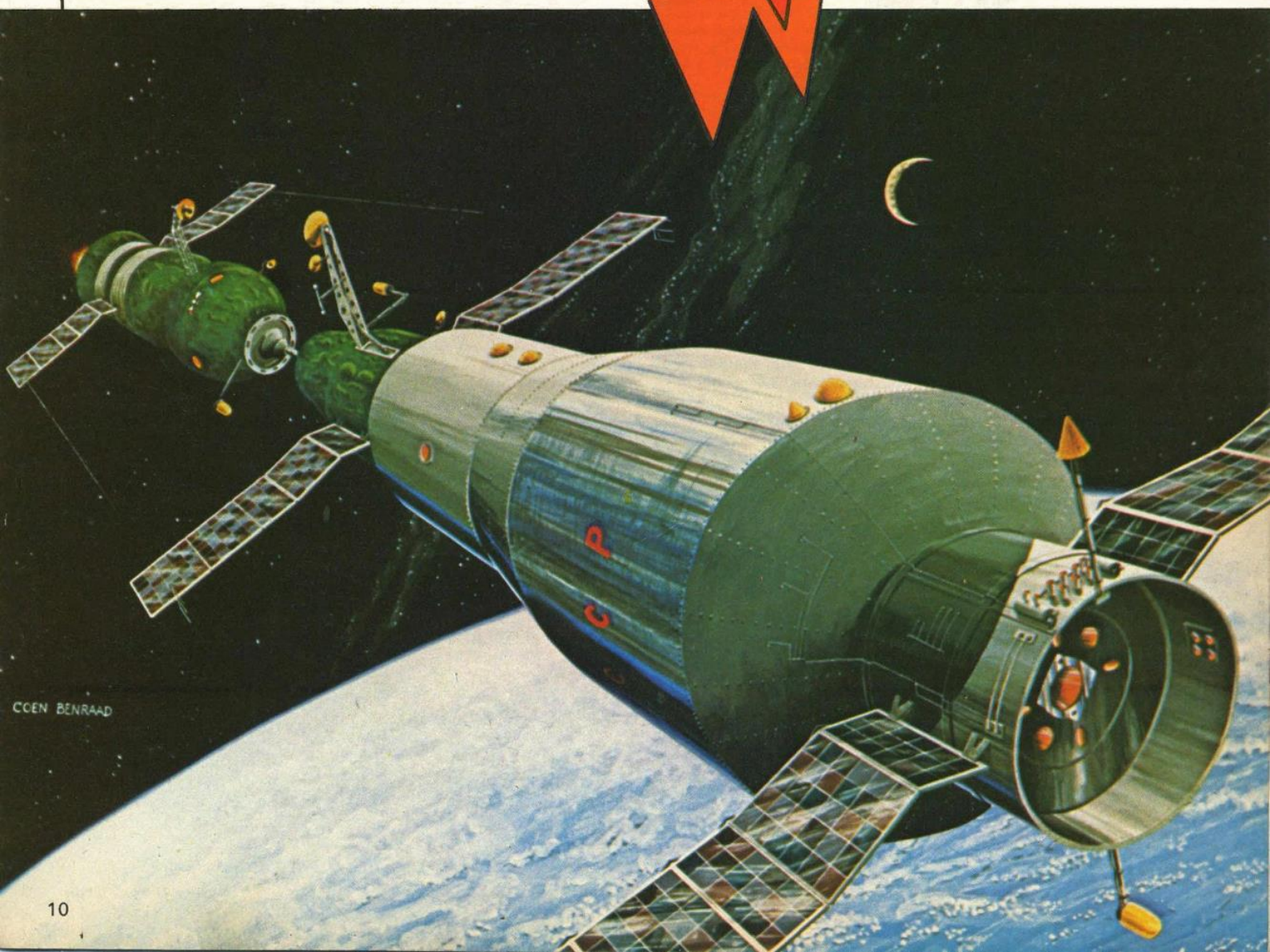
# SOVIETS IN SPACE

*Unlike the Americans, whose exploits in space exploration have always been well publicised, the Russians have been reluctant to give details of the achievements of their cosmonauts. Nevertheless, Russian spacemen have contributed much to man's knowledge of the Universe, sometimes at the cost of their lives . . .*

THE dawn air over the plains of Kazakhstan in Southern USSR was chill as the three Russians walked the few steps from the bus to the waiting lift. Technicians helped them into the tiny cabin at the top of the graceful, fluted tower that was shortly to blast them into space. Small letters stencilled near the entrance hatch identified the craft as *Soyuz 11*. The men were Soviet cosmonauts Vladislav Volkov, Viktor Patsayev and their commander, Lt. Col. Georgi Dobrovolski.

It was 7.55 a.m. on June 6, 1971 as *Soyuz 11* lifted smoothly from the bleak expanse of the Tyuratam space centre. Nearly 200km (125 miles) overhead the world's first experimental space station, *Salyut*, was floating silently along its rigid, circular course. Launched from Tyuratam six weeks previously, it had already received one brief visit when *Soyuz 10* docked with it and then returned to Earth without any attempt by the crew to go on board. It was left to the crew of *Soyuz 11* to become the first.

For nearly 23 days the three



COEN BENRAAD





men, code named Yantar (Amber) —1, 2 and 3, made their home in this 3,500 cu. ft. chamber in space. They broke the previous space endurance record of 17 days, 7hrs set up by *Soyuz 9* cosmonauts Nikolayev and Sevastyanov.

But more important, they performed observations and experiments in space on an unprecedented scale, making observations of the Sun, the stars and Earth as well as testing the technology of the space station. Above all, they proved that well-trained and well-equipped spacemen need suffer no ill effects from a prolonged stay in space.

"Yantar-1, this is Zarya. Are you receiving me?"

"Zarya, Yantar-1 here. Receiving you loud and clear."

It was the kind of radio patter that might be heard at any small airport, although, in fact, it was the beginning of a detailed status report on spaceship *Soyuz 11* as it settled into Earth orbit nine minutes from launch. And the enquiring voice, code named Zarya (Dawn), was that of another cosmonaut, Alexei Yeliseyev, in the Russian Mission Control.

*Soyuz 11* made several orbits of the Earth, the autopilot, and computers checking and correcting its course to enable the crew to manoeuvre the craft into the same tiny corner of space in which *Salyut* was already waiting.

Twenty-four hours later *Soyuz* was only four miles from *Salyut* and Mission control heard the commander's voice call over the radio, "Hallo, Zarya, this is Yantar. I have sighted the target".

The automatic rendezvous system took over, and slowly the gap closed as *Salyut* gleamed hugely in the sunlight only 300 feet away. When only a few feet separated the two, Dobrovolski took over manual control. The computer had done the donkey work, but it required the skill of the cosmonaut pilot to make the final delicate approach.

A few seconds later both the space ship and the space station disappeared below Mission Control's radio horizon, and the actual docking was completed on the other side of the Earth. Once the electrical and hydraulic systems were connected, the cosmonauts gradually equalised the pressures

between the *Soyuz* capsule and *Salyut*, opened the connecting hatch and moved one by one into the much larger space station.

For the next two days the Russian cosmonauts made careful checks of all the equipment in the space station before getting down to the serious work programme assigned to them.

One thing they had been especially asked to report on was the new type of space suit they were wearing. Made of a kind of elastic and shaped rather like a fisherman's waders, it exerted an Earth-like pressure on the muscles to prevent them weakening under the effects of prolonged weightlessness. It was worn almost continuously by the spacemen and had earned the name of the Penguin suit because of the strange waddling walk it necessitated when worn on Earth.

Working a shift system so that two of them were always awake while the other slept, the cosmonauts carried out an extensive number of experiments in the fields of meteorology, geology, and

**CONTINUED ON NEXT PAGE**

**Opposite page: The link-up between spaceship *Soyuz-11* and laboratory *Salyut* (foreground). Three cosmonauts lived in this first space station ever but died on their return to earth due to an air leak. This page, far left: *Soyuz 11* takes off. Left: three *Soyuz 11* cosmonauts aboard their craft. Inset: Interior of the space station *Salyut*.**





# Speed & Power

10p Weekly No. 20 August 2-9, 1974

## Air Racing

*The high-speed sport*

**PLANES SHIPS  
CARS MOTOR BIKES  
SCIENCE FICTION**





*As each year passes more and more of the world's goods are being carried in giant cargo aircraft.*

# Airborne Juggernauts

TODAY, ALMOST any cargo can be flown in special freighters, or in the holds of passenger aircraft. Bulky goods like tons of coal, thousands of gallons of milk, and tons of sand have all been flown. In the future even crude oil and natural gas may go by air. As long as it's not too big or heavy it can fly. But it has not always been easy to move cargo this way.

The first weighty cargo load to take to the air left the ground at Versailles, Paris, almost two hundred years ago. In 1783 the brothers

Montgolfier loaded a sheep, a duck and a cockerel into the basket of a hot air balloon and sent it on its way. It descended about two miles away when the air bag cooled, but just what happened to the unfortunate animals is not recorded.

When the heavier-than-air machine began flying, early aviators naturally turned their thoughts to cargo. In 1909, J. T. C. Moore-Brabazon, later Lord Brabazon, strapped a waste paper basket to the structure of his Short No. 2 biplane, and took a small



Above, right: a picture taken during the Berlin air-lift showing a Bristol Freighter (foreground) and Avro Yorks. Right: an old Dakota flying over Germany. Below: Boeing's proposed 12-engined freighter.

porker aloft to prove that a pig could fly. It could, but that flight proved little else.

As aeroplanes became more reliable their ability to cover distances quickly became more and more attractive. Postal authorities were the first regular major users. In the United States all-weather mail flights were established. The aeroplanes were crude and badly under-powered, and had practically no instruments, so the whole operation became very hazardous.

One pilot trying to get the mail through on a particularly stormy

night found it impossible to keep control of his machine. He let go of everything and shouted, "Here God, you take it—I've done all I can!" The aeroplane crashed, but the pilot survived, indicating perhaps a measure of Infinite Mercy.

It was not until World War II that carrying cargo by air began to make real progress. Battling nations looked closely at designs for all-cargo aircraft. Perhaps the best known and the most successful of all was the C-47 Dakota. The Daks performed astonishing feats, helped greatly in the success

of the Allied Forces in Burma, and enabled the Americans to run a vital airlift across the hump of the Himalayas into China. Many of these old workhorse aeroplanes are still in service.

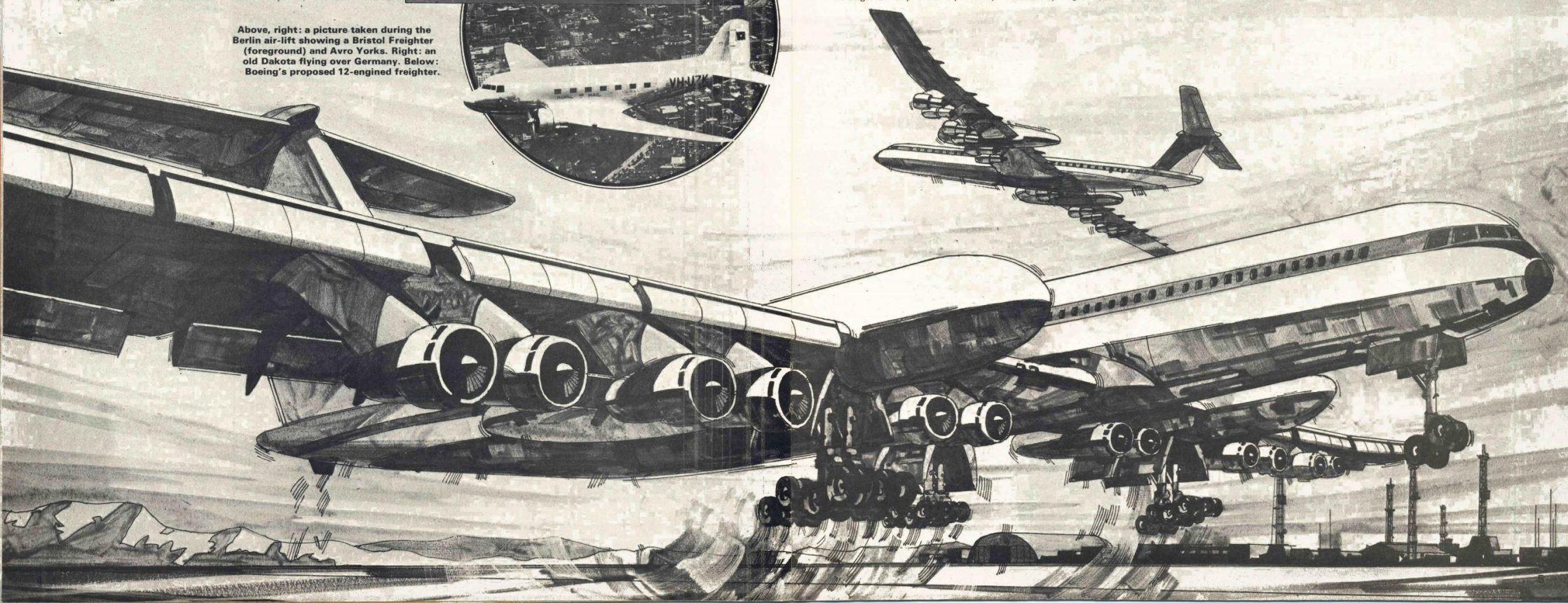
When the war finished the freighters and converted bombers carried thousands of tons of fruit from the Mediterranean to northern Europe, thousands of gallons of milk from Ireland to England and kept the city of Berlin fed and fuelled when road transport was stopped by the Russians. But the payloads of these first-generation

freighters—about eight tons—was small compared with the modern jet.

Today, a giant like the Boeing 747F can swallow 100 tons of cargo into its holds in about 30 minutes. Some gulp!

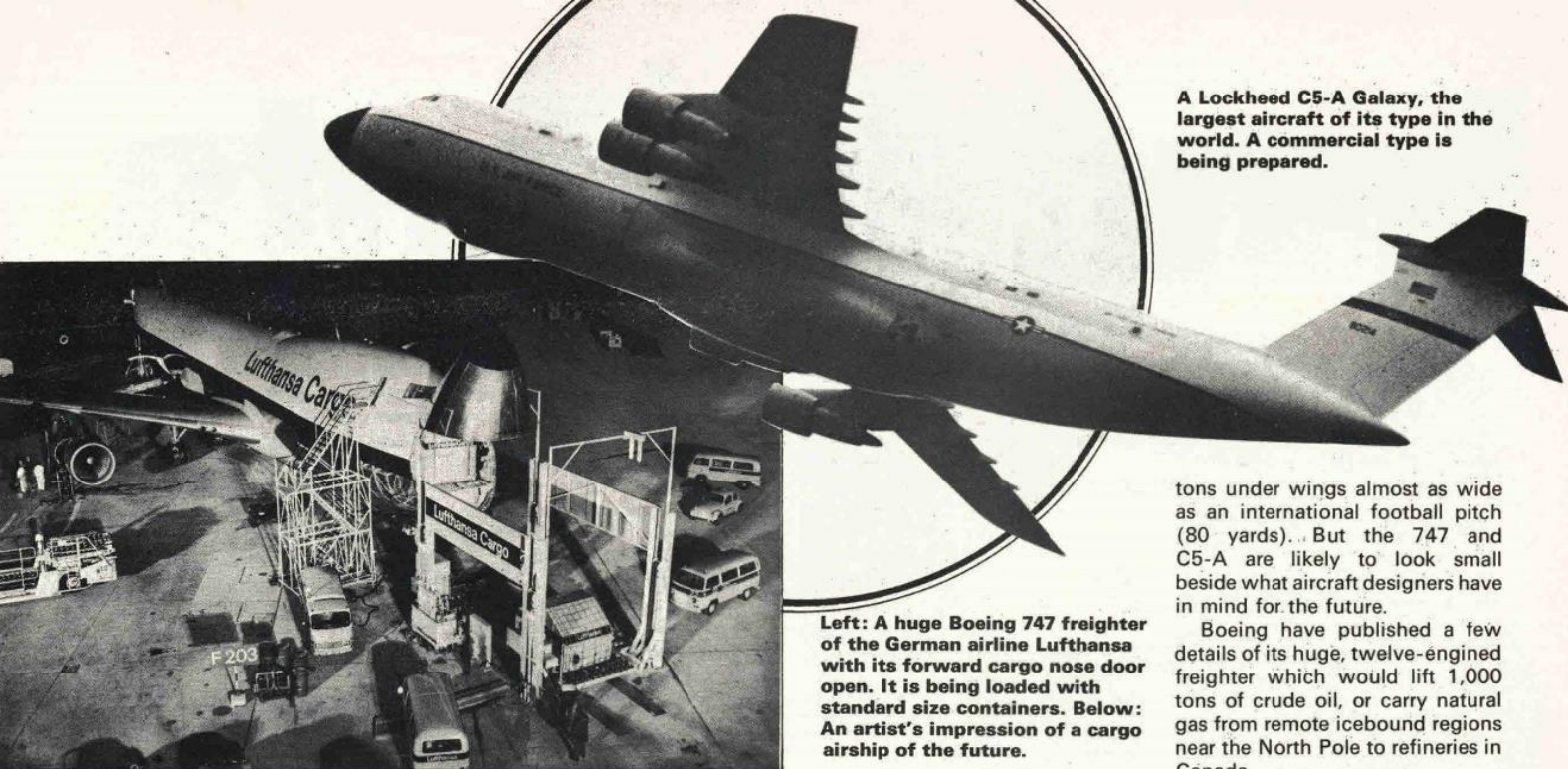
Lufthansa airline carries "cargo" in the shape of 72 Volkswagen passenger cars across the Atlantic. Lockheed planemakers built the truly enormous military C5-A, biggest of its type in the world, and they have a commercial type ready. These planes can carry 130

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**A Lockheed C5-A Galaxy, the largest aircraft of its type in the world. A commercial type is being prepared.**



**Left: A huge Boeing 747 freighter of the German airline Lufthansa with its forward cargo nose door open. It is being loaded with standard size containers. Below: An artist's impression of a cargo airship of the future.**

tons under wings almost as wide as an international football pitch (80 yards)... But the 747 and C5-A are likely to look small beside what aircraft designers have in mind for the future.

Boeing have published a few details of its huge, twelve-engined freighter which would lift 1,000 tons of crude oil, or carry natural gas from remote icebound regions near the North Pole to refineries in Canada.

Called the Arctic Resources Airplane (ARA) it will be powered by twelve 50,000lb thrust jets, bigger even than those of the Galaxy, and it will need that much power to get its bulky 2,000 tons into the air.

The advantage of using an air freighter to carry oil is that it will fly to areas where ships or a pipeline cannot be used. The freighter will then deliver the crude oil straight to a refinery.

Not quite so ambitious as the ARA is another Boeing project. It is for a large simple freighter that will carry the big 40 feet long and 8 feet square containers that normally travel by rail, road and sea. These aircraft will be little more than a simple powered box with an airfoil section fuselage to get some extra lift.

Now, the air cargo carrying business is coming full circle. It started with gas and hot air balloons, and much of it in the future may be carried in helium-filled airships. The Soviet Union are already talking about a nuclear powered airship with an 180 ton payload. It would fly at a relatively low speed of about 200mph, and could lift heavy cargo and bulky engineering equipment which would be suspended underneath.

In Britain, one London company is working on a project which could look like an airship from the 1920s, but it would carry 100 million cubic feet of natural gas. The gas might be used to give some lift. So we could soon see enormous aircraft winging through the sky—or some heavy loads swinging under them.





10p Weekly No. 21 August 9-16, 1974

# Speed & Power

**DARE-DEVIL TT RIDERS**



**MEN BEHIND RACING**



**PLANES SHIPS TRAINS**

**SCIENCE FICTION**



# SATURN TRANSPORTER

*The mighty Saturn V rocket can accelerate space vehicles to over 25,000 mph, but the first few miles of a journey to the Moon begins on the ground – at a speed of just one mile an hour!*

THE APOLLO voyages to the Moon have been the source some pretty fantastic achievements and staggering statistics. Most of these are concerned with the size and power of the Saturn V launch vehicle, the speeds achieved, the complexity of various operations, and so on. But, among all this there is one largely unsung hero. This is the vehicle which performs the down-to-Earth job of transporting the complete rocket from the assembly building to the launch pad (and back again when, on one or two occasions, it has proved necessary). The vehicle is known simply as "the transporter".

When NASA officials decided on the design of the Saturn V, they also realised that such a launch vehicle was too large and delicate to assemble horizontally and erect on the pad the way the Russians preferred. Nor would assembly on the pad itself be suitable because it would be exposed to the elements too long during the long operation of putting a Saturn V together and checking it out.

But Apollo planners were used to thinking big, and think big they did! The result was the gigantic Vehicle Assembly Building, known simply as VAB, plus a mobile launch platform and the Transporter.

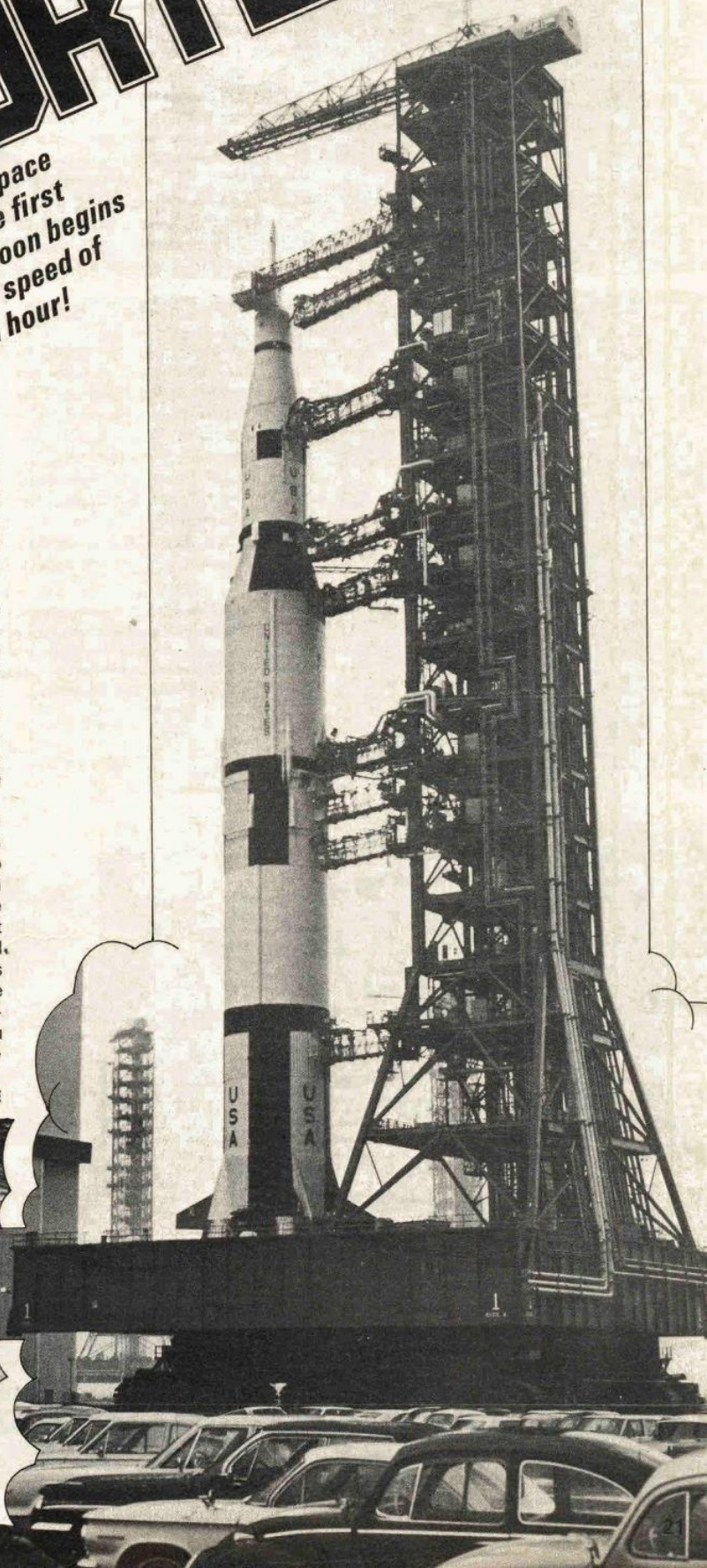
The Saturn V stages and the Apollo spacecraft are all put together right on the launch platform which is parked inside the VAB. The platform is a steel structure 25ft. high, 160ft. long and 135ft. wide, or about half an acre in area. It stands on six, 22ft.-long, retractable pedestals, when in the VAB or on the pad.

On one end is mounted the 398ft. high tower which carries the necessary wiring and piping to the different parts of the rocket. In the middle is a 45ft. square hole through which the lift-off blast passes to a flame trench in the pad, below. The whole structure weighs 5,350 tons. Add the weight of the unfuelled Saturn V/Apollo (actually a mere 236 tons) and you have a need for something pretty powerful to carry it all.

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**Above: Three launch platforms under construction at the Kennedy Space centre. In the background is the huge Vehicle Assembly Building. Right: A Saturn V leaves the VAB on a transporter.**





The transporters (three of them were built) are the largest tracked vehicles in the world. Each weighs some six million pounds, almost as much as a launch-ready Saturn. A flat deck some 90ft. square and just low enough to slip under the launch platform on its 22ft. legs, rides on four double-tracked crawlers. Each crawler is a mighty vehicle in itself, larger and more powerful than the biggest tanks in service, and measuring 40ft. in length, 10ft. in height, and with each shoe weighing about a ton. The entire transporter vehicle 131 ft. by 114ft. overall, would cover more than half of a football pitch!

### INSTRUMENTS

The drivers—or operators as they are called—sit before an array of instruments like that of an aircraft panel in a cab on top of the right-hand front crawler—whichever way they are going. In other words there is an identical cab at each end on diagonally opposite corners.

Power is provided by 16 traction motors driven by four 1,000kW

generators and the speed of the vehicle is controlled by varying the generator fields. The generators are themselves driven by two 2,750hp diesel engines. There are also two other 1,065hp diesel engines which drive a pair of 750kW generators to provide the power for the field variation as well as for the steering, jacking, lighting, electronics and other systems.

The transporter is not a vehicle in which to win any Grand Prix races. Maximum speed when loaded is about one mile per hour. Unloaded, it can accelerate up to two miles per hour. In fact, the 3.5-mile trip from the VAB to the launch pad is usually performed at half speed and takes about seven hours. But what other vehicle on Earth could outpace it when carrying 6,000 tons on its back?

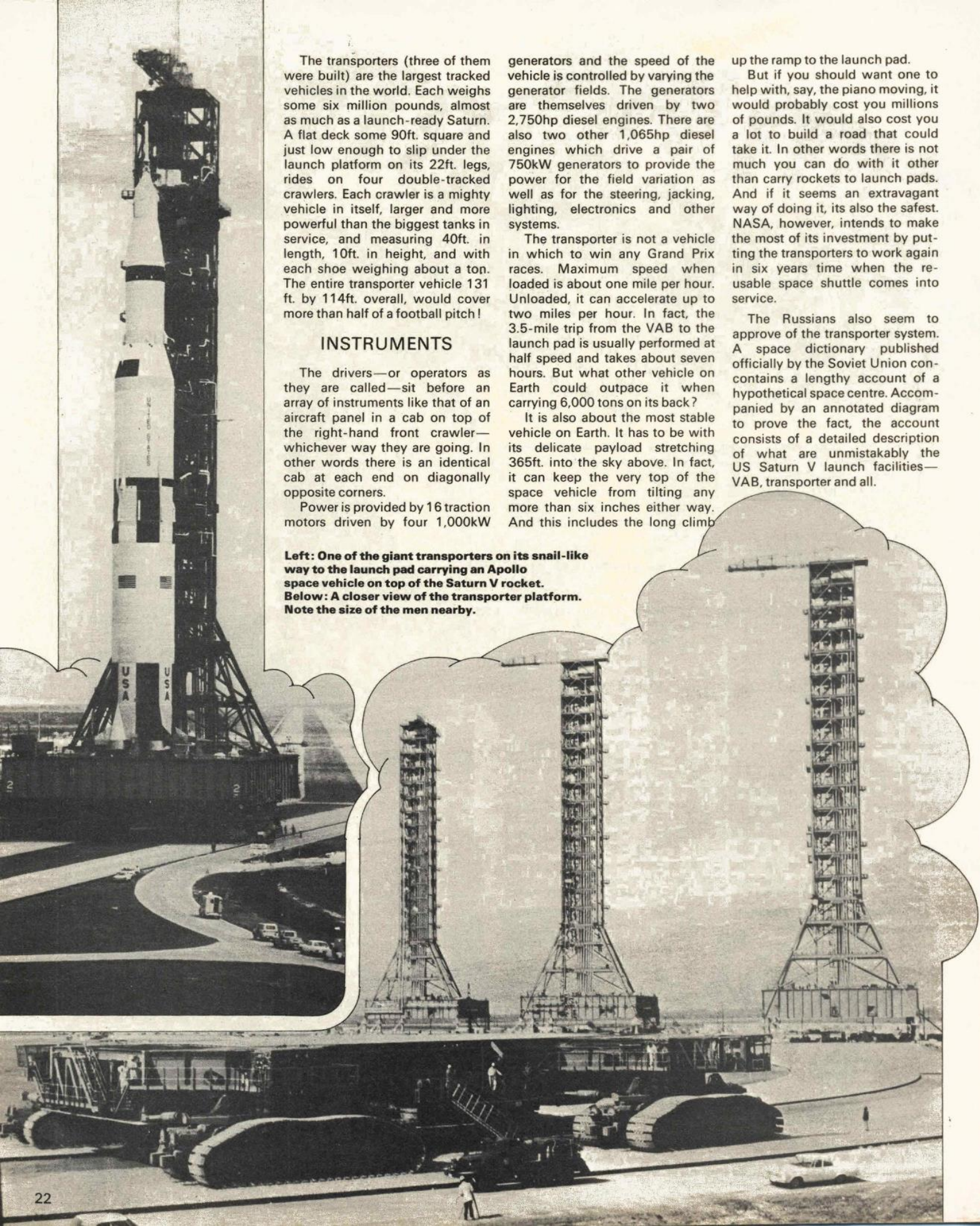
It is also about the most stable vehicle on Earth. It has to be with its delicate payload stretching 365ft. into the sky above. In fact, it can keep the very top of the space vehicle from tilting any more than six inches either way. And this includes the long climb

up the ramp to the launch pad.

But if you should want one to help with, say, the piano moving, it would probably cost you millions of pounds. It would also cost you a lot to build a road that could take it. In other words there is not much you can do with it other than carry rockets to launch pads. And if it seems an extravagant way of doing it, it's also the safest. NASA, however, intends to make the most of its investment by putting the transporters to work again in six years time when the reusable space shuttle comes into service.

The Russians also seem to approve of the transporter system. A space dictionary published officially by the Soviet Union contains a lengthy account of a hypothetical space centre. Accompanied by an annotated diagram to prove the fact, the account consists of a detailed description of what are unmistakably the US Saturn V launch facilities—VAB, transporter and all.

**Left: One of the giant transporters on its snail-like way to the launch pad carrying an Apollo space vehicle on top of the Saturn V rocket. Below: A closer view of the transporter platform. Note the size of the men nearby.**





The *Bazin*, designed in 1896, was the largest and most famous roller ship of its time.

## Freak Ships

# Rolling Across The Waves

THE possibility of driving a wheeled vehicle at sea must have seemed a crazy notion to sailors one hundred years ago. Since that time of course wheeled vehicles, mainly concerned with modern warfare, have been designed and built but none looked like Robert Fryer's steam driven roller ship of 1882.

She must have been very

strange indeed. Her designer considered that by rolling over the waves on large floating wheels the friction of the sea water encountered by conventional hulls would be reduced and the vessel could travel faster with less power. It should be remembered that most steam ships at that time still used paddle wheel propulsion and with these a great deal of effort

was wasted through inefficiency.

The *Alice*, as she was called, consisted of a triangular framework resting on three wheels in the layout of a tricycle. Six feet in diameter, they were fitted with bucket-like flanges on their edges (to push on the water), while their outer circumference had an iron wagon tyre in order that the vehicle could travel across land like a true amphibian. The whole contraption was propelled by a steam engine with a tall funnel.

Little is known of the outcome of the *Alice*, except that she was the obvious forerunner of another amphibious roller ship, called *Svanen*, built in 1895. The *Svanen* carried passengers across two separate lakes in Denmark, crossing the intervening strip of land on a set of railway lines. Apparently she was very successful indeed and carried up to 70 passengers a day for many years.

Perhaps the largest and the most famous roller ship of all was the *Bazin* that was designed by Ernest Bazin in 1896.

Ernest Bazin's theory was that if a hollow wheel floated vertically in the water and was pushed forward it would have the same effect as a blunt ended boat. If, on the other hand, it was rotated and simultaneously pushed through the water by an outside force the

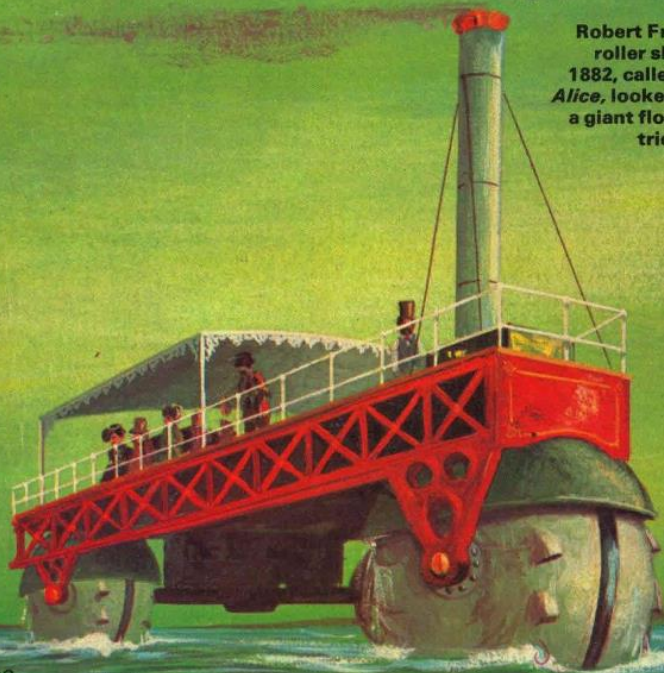
wheel would move with little friction. A 16ft working model was built to prove the theory, and this was so successful that the finance to construct a full-scale ship was soon found.

The *Bazin* consisted of a platform 126ft long and 40ft wide, fitted with three driving shafts each housing a pair of buoyant wheels 33ft in diameter and 10ft wide at the hubs. The platform floated about 10ft above water, high enough to be clear of normal Channel waves. The deck formed the ship proper and contained accommodation for passengers and crew, bridge, boiler house, engine room and bunkers.

Propulsion was provided by three 50 hp engines each rotating an axle plus a 550 hp engine driving the propeller through a shaft similar to the outboard motor.

Bazin's intention was to use his ship on a cross-Channel service until she had established a reputation for steadiness and stability, and then to construct a larger, eight-wheeled vessel for the Atlantic. However, apart from sundry trial trips in the Channel, in which the speed fell considerably short of the designed 30 knots, the *Bazin* does not appear to have made any impact on history other than as a crude nineteenth-century forerunner of the modern hovercraft.

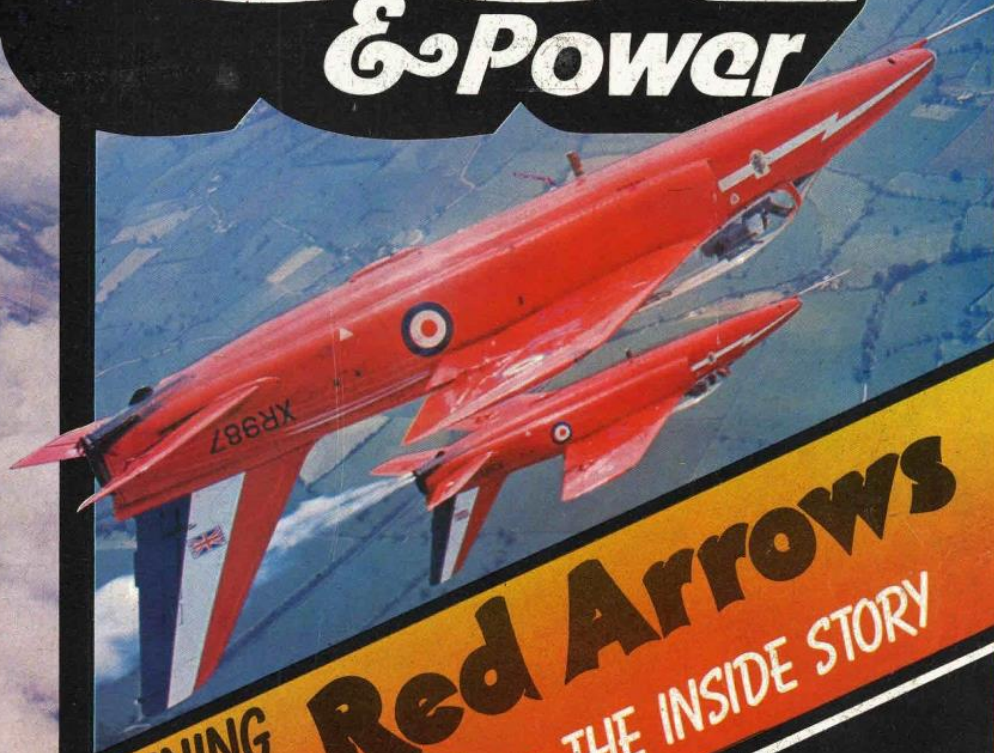
Robert Fryer's roller ship of 1882, called the *Alice*, looked like a giant floating tricycle.





10p Weekly No. 25 September 6-13, 1974

# Speed & Power



EARTH-SPINNING  
WORLD OF THE  
**Centurion Tank**

**Red Arrows**  
THE INSIDE STORY



**PLANES TRAINS SPACE  
CARS SCIENCE FICTION**



# EUROPE'S SPACE WORKSHOP

**M**ANNED SPACE research is a very costly business, and until recently there were no signs that any other country was even thinking of "going it alone" as the United States and the Soviet Union have done to initiate the Space Age.

But if a number of countries get together and pool their resources and skills the outlook suddenly looks different. And that is what is happening. Already on the horizon is a co-operative development that could prove a real shot in the arm for manned space flight. It will give Western Europe a sizeable stake in this most exclusive flying club, and draw on Europe's considerable technical know-how, particularly in the field of aviation.

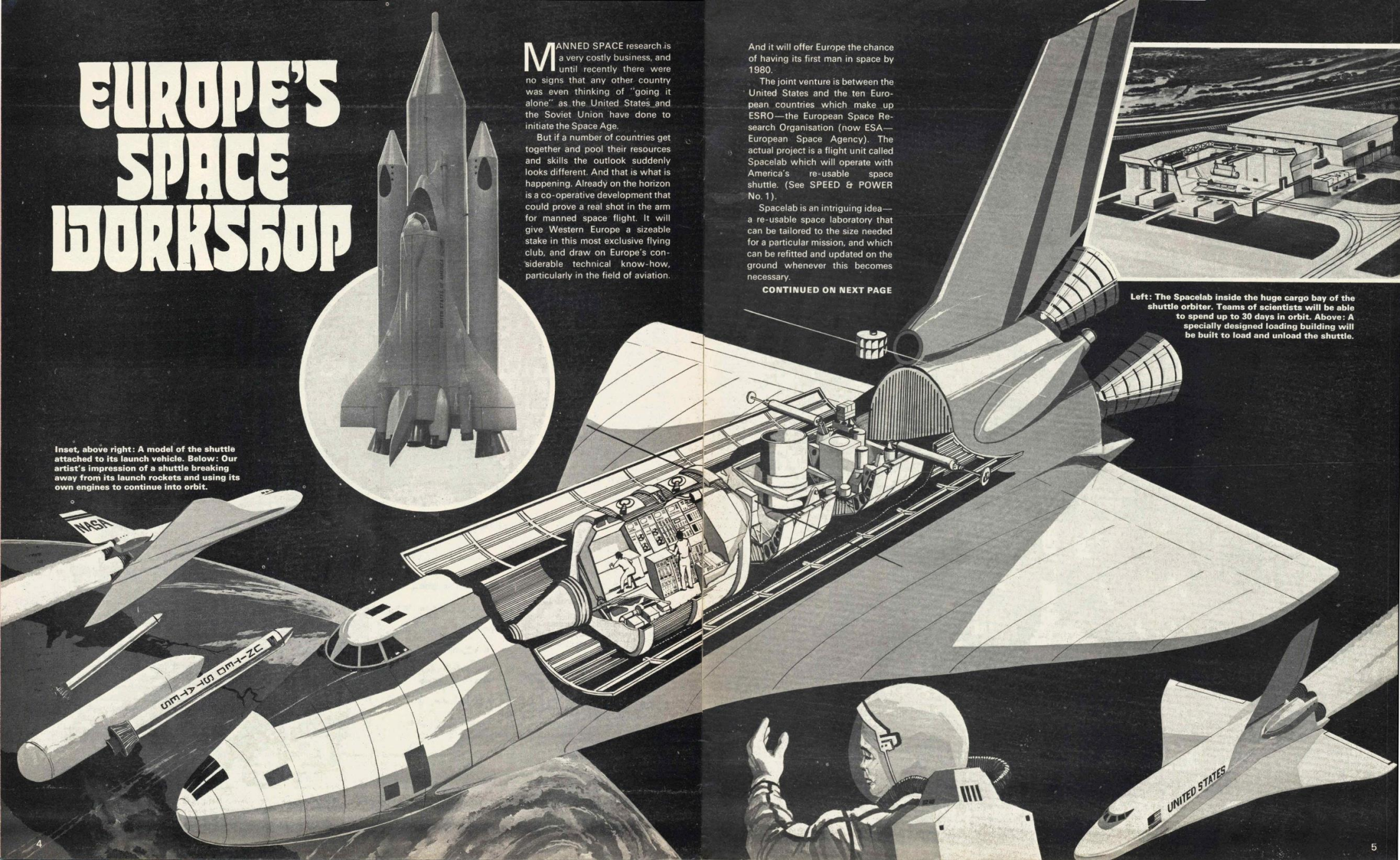
And it will offer Europe the chance of having its first man in space by 1980.

The joint venture is between the United States and the ten European countries which make up ESRO—the European Space Research Organisation (now ESA—European Space Agency). The actual project is a flight unit called Spacelab which will operate with America's re-usable space shuttle. (See SPEED & POWER No. 1).

Spacelab is an intriguing idea—a re-usable space laboratory that can be tailored to the size needed for a particular mission, and which can be refitted and updated on the ground whenever this becomes necessary.

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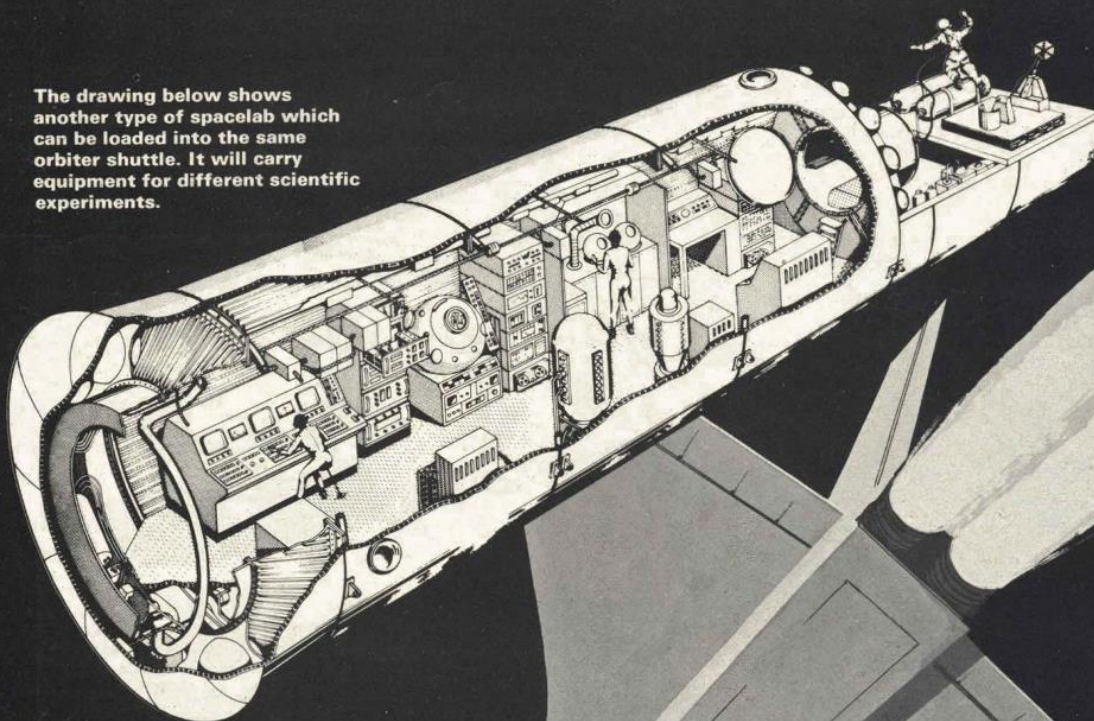
Inset, above right: A model of the shuttle attached to its launch vehicle. Below: Our artist's impression of a shuttle breaking away from its launch rockets and using its own engines to continue into orbit.



Left: The Spacelab inside the huge cargo bay of the shuttle orbiter. Teams of scientists will be able to spend up to 30 days in orbit. Above: A specially designed loading building will be built to load and unload the shuttle.



The drawing below shows another type of spacelab which can be loaded into the same orbiter shuttle. It will carry equipment for different scientific experiments.



It will have two basic elements—a working section and an instrument platform. The working quarters will be in a cylindrical tank, 14 feet in diameter and up to 59 feet long, depending on the number of modules used. This part of Spacelab will be pressurised so that the crew will work in an atmosphere identical to that on Earth. They will however, be weightless. The instrument platform, outside the main cylinder, will be used to house telescopes, antennae and other equipment which must be exposed directly to space. It will not be pressurised, and its instruments will be operated either from inside the cabin, or by radio from ground stations.

Spacelab will ride as a passenger into orbit—inside the giant bay of the space shuttle orbiter. When it reaches the correct operating altitude for the mission it will be deployed, but will remain attached to the Orbiter, to which the crew of six scientists and engineers will return to eat and sleep.

Missions will last from seven to 30 days. When they are completed, Spacelab will be loaded back into the shuttle and flown back to the Cape Canaveral launch site, where the shuttle will make an aircraft-type landing.

Then, while the shuttle itself is being prepared for another mission, new equipment will be installed in Spacelab so that a different set of experiments or work tasks can be carried out. Each



When the 30-day mission has been completed the outer panels of the shuttle are closed to protect the crew from the intense heat of re-entry. The shuttle vehicle finally makes a normal aircraft landing. After landing the space laboratory will be removed from the shuttle and fitted out for its next mission in Space. Bringing the lab back to Earth instead of abandoning it in Space will save millions of pounds.



Spacelab will be designed for up to 50 flights.

American space experts now working on the shuttle estimate that nearly half of its flights will be missions to launch small satellites, to carry out running repairs to those whose batteries or other replaceable parts have failed, or to bring back to Earth those which need major servicing.

So if everything goes according to plan, Spacelab could be making hundreds of flights during the 1980s, and become a key element in the post-Apollo programme of manned space research. It's just as well, perhaps, that Spacelab's crew members will need only a few months of easy training compared with the long years of drilling that pilot astronauts need. For, by the

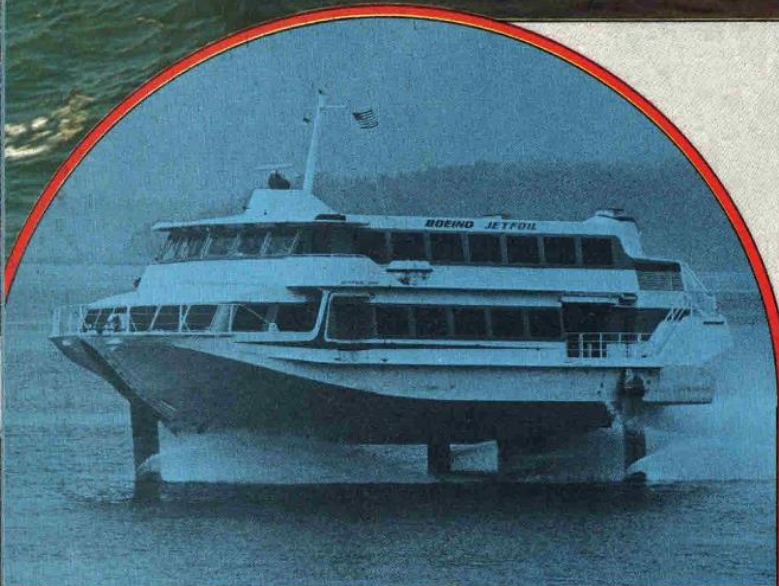
look of things, lots of them will be needed.

The final design for a Spacelab can be seen in the drawing. A six-year contract was awarded in July to a group of European companies headed by VFW-Fokker/ERNO. Delivery of the first flight unit, ready for experimental work, is to be in April 1979, with the first launch taking place early in 1980.



# FOILS for the FUTURE

Below: *HMCS Bras D'or* of the Canadian Armed Forces powers through the water. This de Havilland hydrofoil is capable of well over 60 knots.



## Jetfoil

The exciting hydrofoil above is the Boeing Aerospace Company's first jetfoil boat which successfully began its high-speed tests on Puget Sound in America recently. You will remember seeing our artist's impression of this boat in *Speed and Power* No. 5. The red, white and blue craft reached speeds of 37 knots (42.6mph-68.5kph).

Engineering tests are continuing and Boeing will soon start tests on the Pacific Ocean at speeds up to 45 knots.

**T**RAVEL ON water, like other forms of transport, is becoming faster all the time, as technology advances. The modern method of speeding over the sea is by hydrofoil. At speed, these craft rise several feet above the water on stilts and are sometimes known as "boats that fly" (see *Speed & Power* No. 4).

It is not surprising therefore that an aircraft company such as de Havilland of Canada are well advanced on the hydrofoil scene.

As well as building commercial and military planes they have, since 1960, been designing and constructing powerful hydrofoils.

Among these is the handsome *HMCS Bras D'or*, built specially for operation with the Canadian Armed Forces. It was designed for speeds of up to 60 knots, but exceeded this on early demonstration runs in 1969.

*Bras D'or* is powered by four gas turbine engines, the most powerful of these being 25,000 horse-power, used for main foil-borne propulsion. Two of the engines are small and used only for deck pumping and in an emergency.

The boat's role is as an anti-submarine escort vessel. In exercises carried out with the Canadian

destroyer fleet, *Bras D'or* demonstrated her excellent rough water sea-keeping capabilities.

The de Havilland Company are now planning a new type hydrofoil able to perform a variety of roles. This will be a slightly smaller craft with a weight of just over 100 tons and a top speed of 50 knots.

Adaptability will be the keynote of the sleek new hydrofoil. It will be possible to fit it out for a number of roles, including that of a gunboat for coastal patrol and escorting larger ships. In this guise it would have a Bofors 57mm gun, and a smaller gun for self-defence on the afterdeck. Because of a very stable foil system, the accuracy of shot of such a boat will be excellent.

The new hydrofoil will also be able to carry a missile system such as Exocet which can be used to attack other craft on the surface within 20 nautical miles.

Equipped with sonar (under-water detection) equipment, the hydrofoil will be an effective anti-submarine vessel. Once a sub has been located, it can attack at high speed, using torpedoes mounted in tubes and fired from the operations control room.

The boat would not only be use-



Photos: courtesy de Havilland of Canada



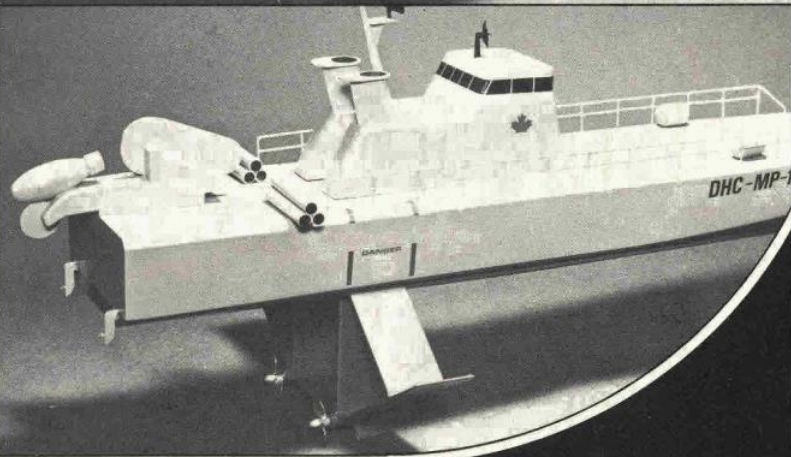
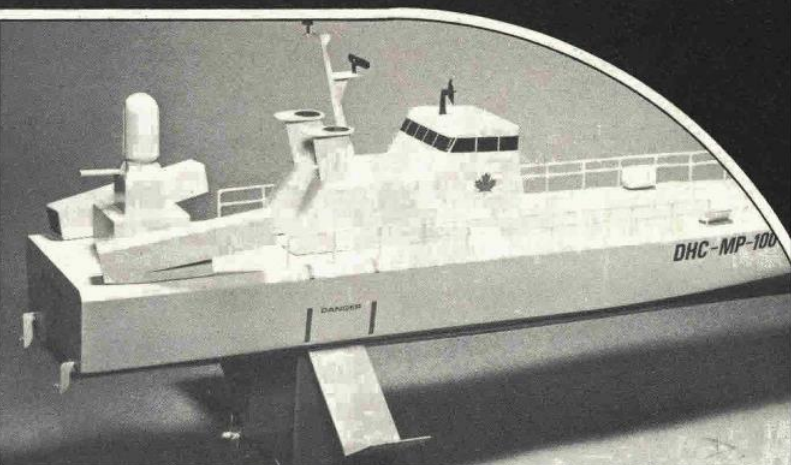
ful in wartime. Its high speed and buoyancy would enable it to be used as a fast rescue launch for oil rigs or ships. It could even tow a disabled ship back to safety.

Powered by two 3,100 horsepower gas turbines and two 400 hp diesels, it will carry sufficient fuel for a range of about 642 nautical miles at cruising speed. A crew of nine men (excluding officers) could operate it in most roles.

A fast, multi-role boat is a necessary requirement for the navies of the future, and the

versatile de Havilland 100 ton hydrofoil could well be the answer. Its surface-piercing foils, and propulsion in the form of propellers or waterjets, will give it speed and steadiness.

**Top:** A model of the hydrofoil for the future now being planned by de Havilland, showing the numerous roles it can be equipped to carry out. This is the powerful gunboat version and (top right) the missile carrier; (right) the anti-sub torpedo-carrying model.

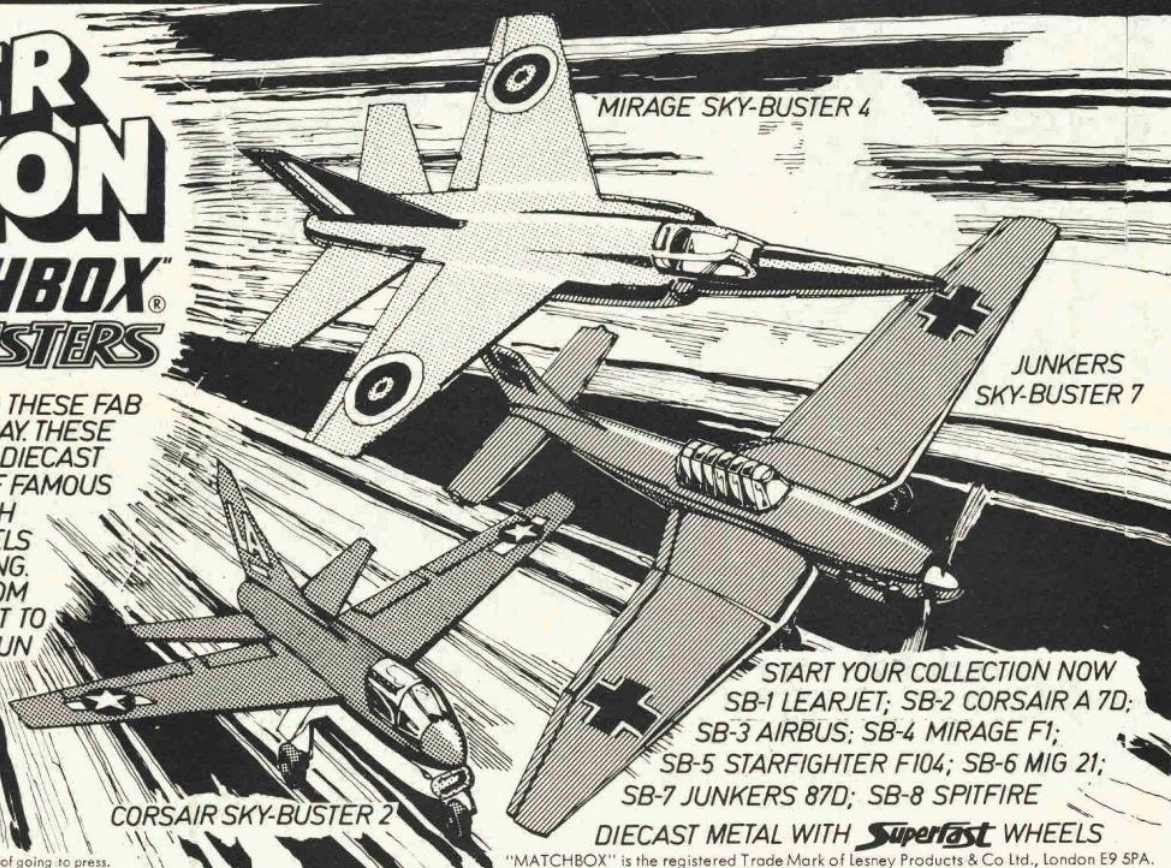


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# CENTURION TANK



A Centurion from the 1st Royal Tank Regiment on an exercise in a German training area. The plates along the sides shield the tracks from bazooka attacks which disable the tank.

THE CENTURION tank is one of the most famous and successful tanks ever built. Developed towards the end of the last World War, it arrived in service too late to take part in action, but until very recently it has remained the mainstay of the British armoured formations. It is in the process of being replaced by the more powerful Chieftain tank. Apart from being used by the British Army, the Centurion has seen very dramatic service with foreign armies, perhaps the most striking being its use by the Israelis during their lightning war against the United Arab Republic.

When it first appeared the Centurion was armed with a 17-pounder anti-tank gun—a converted artillery piece which had proved very effective against German heavy tanks. The early production models, however, were armed with a 20-pounder gun (84mm) which enabled the tank

to engage the heaviest armour. During the late 1950's the Centurion received an even more powerful gun in the form of the 105mm, which has been adopted since as the standard main armament of all NATO tanks. The last model of the Centurion tank is the Mk13, although 21 different types have been produced. Apart from changes in armament, the Centurion has also been progressively up-armoured and been given an increased fuel capacity, ranging machine-gun, new sighting equipment and other modifications—including devices to enable it to fire at night and to cross rivers.

What makes the Centurion such a good tank is its overall design—the powerful 12 cylinder Meteor engine, the specially-designed Merritt-Brown transmission, the very thick armour and the excellent suspension. The suspension is, in fact, what is called a "Horstmann" type in that it utilises vertical coil springs. This type of suspension was used a great deal on early (inter-war) British light tanks and machine-gun carriers, but the Centurion was the first application to a heavier tank. The advantage of the Horstmann suspension

is that it is very robust and that all the components are attached to the outside of the hull, thereby allowing maximum room inside the tank.

The 105mm gun can fire two basic types of round—the HESH and the APDS. The HESH (High-Explosive Squash-Head) is a relatively slow round which explodes on impact, and is generally used to engage stationary targets—such as bunkers, parked vehicles, etc. The APDS (Armour-Piercing Discarding-Sabot) is used for destroying fast-moving armoured targets, such as tanks. It contains no high-explosive, is simply a solid slug of very hard metal, and drills its way through very thick armour. This type of ammunition is very fast and accurate, even when firing at moving targets.

Since it was such a successful tank, and because its performance is still in keeping with modern tactical demands, the Centurion has been utilised as the basis for a whole series of special-purpose tanks. These special purpose tanks are there to enable the normal tanks (Chieftains) to reach their objective despite enemy counter-measures. For example, the Centurion bridgelayers (there are two types) are normal Centurions with the turrets removed, having ingenious folding bridges which may be extended across wide trenches even under fire. Normal

tanks may then proceed to cross the bridges. As the result, the trenches of the First World War are no longer serious obstacles to the tank's advance.

Another important modification of the Centurion is the Armoured Vehicle Royal Engineers (AVRE, for short) which is a normal Centurion having a 6.5 inch howitzer in place of the 105mm gun, and other special attachments such as a bulldozer blade. This vehicle may assist the engineers to carry out their tasks even under fire. The AVRE can also tow a trailer which has a very interesting mine-clearing device. It is called the "Giant Viper", and consists of a long hose full of high explosive, with a rocket attached. When the rocket is fired it pulls the hose across a minefield, the hose being detonated from within the tank on landing. The explosion then sets off the buried mines and clears a path for the advancing troops. The Giant Viper is a quick and effective means of clearing a path through minefields under fire.

For recovery of damaged tanks under fire, a special Armoured Recovery version of the Centurion exists (called ARV for short). This is a normal Centurion tank with the turret removed and a fixed superstructure in its place. The superstructure contains a second engine which drives a winch. The vehicle can, as the result, tow damaged tanks out of ditches or other obstacles. For recovery during beach landings the BARV has been developed (Beach Armoured Recovery Vehicle), which is similar to the ARV but has a much higher armoured fixed turret enabling it to wade through deep water.

The standard Centurion may be fitted with special equipment, including a snorkel, to enable it to run along the bottom of rivers. Details of the Centurion Mk 13 tanks are given below.

Crew: 4 men—commander, gunner, loader and driver.  
Weight: 51 tons  
Length: 25 ft. 8 ins.  
Width: 11 ft. 1 1/2 ins.  
Height: 9 ft. 9 ins.  
Range of action: 118 miles.  
Maximum speed (on roads): 22mph.  
Armament: 105mm and 2 machine-guns (also a ranging machine-gun).  
Ammunition: 64 rounds of 105mm

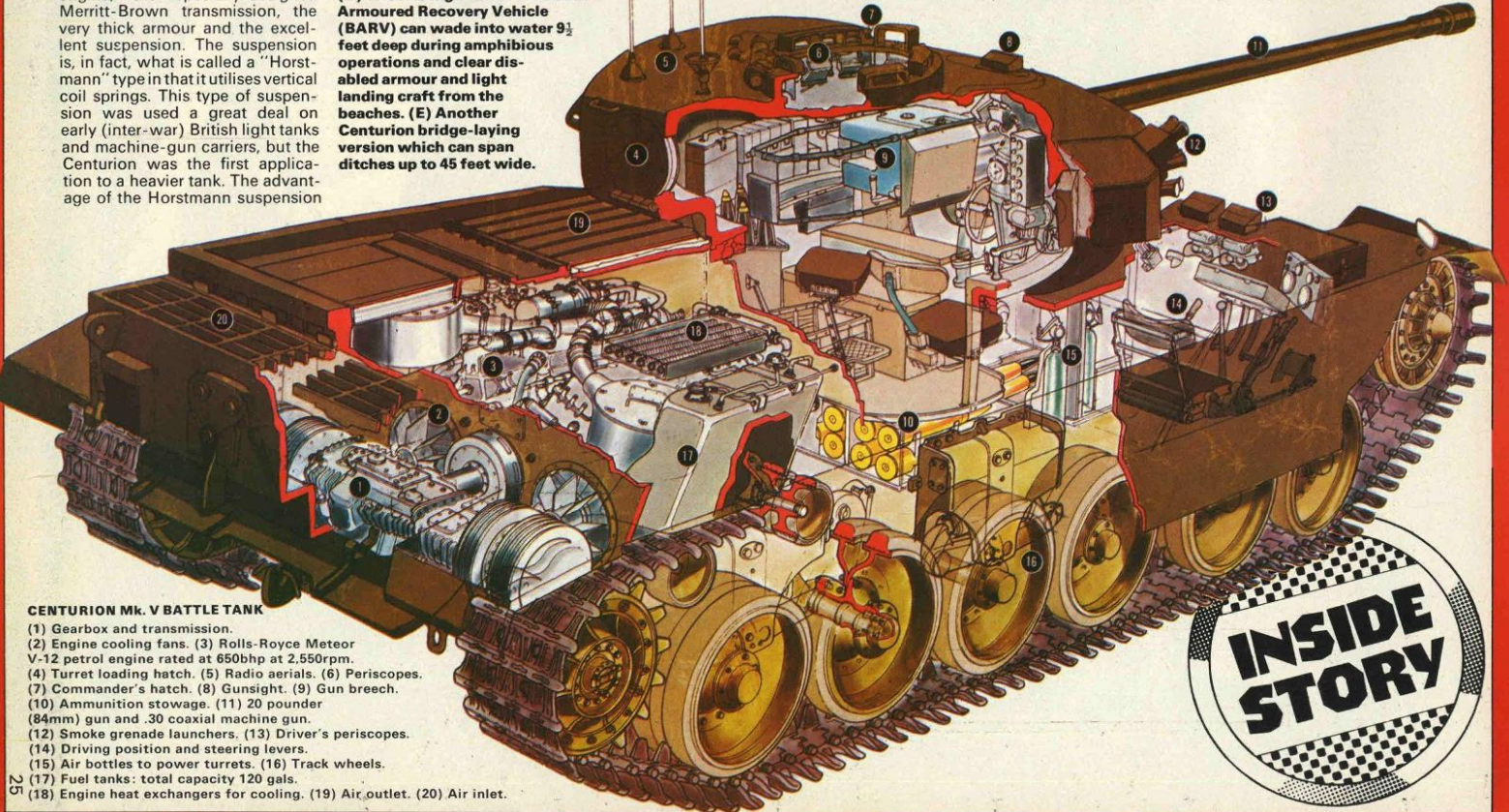
Engine: 12 cylinder V-Type, water-cooled, Meteor petrol engine developing 650 BHP at 2550rpm.

All the specialised vehicles shown here are based on the Centurion tank chassis. (A) An Armoured Vehicle Royal Engineers (AVRE), armed with a low velocity 165mm demolition gun for attacking steel and concrete fortifications. It also has a bulldozer blade and tows an armoured trailer fitted with the Viper mine clearing system. (B) An Armoured Recovery Vehicle (ARV) used to recover damaged heavy AFVs in forward battle areas. It is fitted with an electrically-driven winch with a maximum pulling power of 90 tons. (C) The ARK bridgelayer, shown folded. The span opens out to form a bridge 75 feet long.

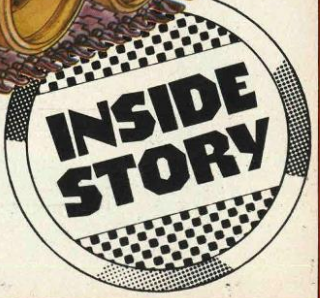


(D) With its high turret the Beach Armoured Recovery Vehicle (BARV) can wade into water 9 1/2 feet deep during amphibious operations and clear disabled armour and light landing craft from the beaches. (E) Another Centurion bridge-laying version which can span ditches up to 45 feet wide.

Photos: Christopher Foss/Peter Chamberlain/MOD.



- CENTURION Mk. V BATTLE TANK**
- (1) Gearbox and transmission.
  - (2) Engine cooling fans. (3) Rolls-Royce Meteor V-12 petrol engine rated at 650bhp at 2,550rpm.
  - (4) Turret loading hatch. (5) Radio aerials. (6) Periscopes.
  - (7) Commander's hatch. (8) Gunsight. (9) Gun breech.
  - (10) Ammunition stowage. (11) 20 pounder (84mm) gun and .30 coaxial machine gun.
  - (12) Smoke grenade launchers. (13) Driver's periscopes.
  - (14) Driving position and steering levers.
  - (15) Air bottles to power turrets. (16) Track wheels.
  - (17) Fuel tanks: total capacity 120 gals.
  - (18) Engine heat exchangers for cooling. (19) Air outlet. (20) Air inlet.





Many an engineer with a cargo carrying problem must have wished for a magic carpet. Now a British company has waved its magic wand and produced these giant air cushion transporters!

# Going to Work Magic Carpet

**B**IG LOADS normally need big transporters to shift them. But what kind of transporter can carry cargo overland, over water and back onto land again... from door-to-door no matter what sort of terrain it has to pass over? The fairy-tale answer is a magic carpet, but the engineering equivalent of that is a hover platform which can carry tremendously heavy loads on a cushion of air.

But this is no fairy tale story for the latest air cushion transporters (ACTs) are BIG. Built by Mackley Ace of Southampton, two ACTs currently nearing completion will weigh 730 tons when fully loaded and measure 180 feet long by 80 feet wide.

The two platforms are being constructed at Abu Dhabi in the Middle East to help carry large prefabricated sections, some of them weighing 200 tons, which will form part of a

new natural gas liquefaction plant on Das Island, some 110 miles from Abu Dhabi. Das is a barren, rock strewn area with no docks or harbours and is separated from Abu Dhabi by sea. Journey by conventional vehicles, first overland, then by ship and finally overland again would have proved extremely costly until the idea of using the amphibious ACTs was hit upon.

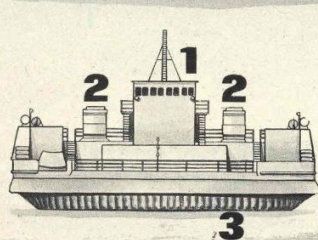
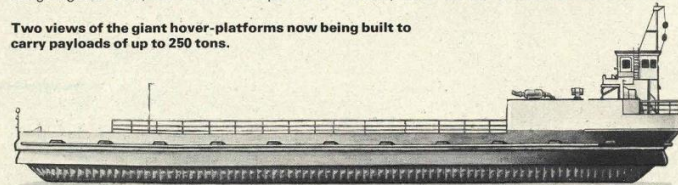
Because they are not self-propelled the hoverplatforms will have to be towed from Abu Dhabi by tugs. For most of the year the seas in this area have waves only two feet high, but sudden storms can soon whip up the water. Even so, the ACTs can cope and will easily ride out a heavy swell.

On arrival at Das Island, crawler tractors will be used to tow the ACTs, which will still be on hover, out of the sea and across half-a-mile of

desert to the construction site. There the sections of plant can be off-loaded directly onto their foundations. By not having to build special roads, a small railway or use heavy vehicles, the cost of the move has been kept to a minimum.

Each platform has two fans, driven by two V-12 diesel engines developing a total of 1650 bhp. These suck in a massive 135,000 cubic feet of air every minute, creating a cushion pressure of 1lb per square inch sufficient to give the ACT and its 250 ton payload a hover height of four feet.

Two views of the giant hover-platforms now being built to carry payloads of up to 250 tons.

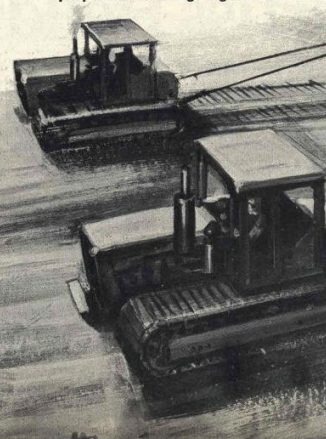


## KEY

(1) Bridge house for crew of four and ship's master.

(2) V-12 diesel engines driving fans.

(3) Flexible skirt forming air seal with ground. Length of the ACT is 180 feet by 80 feet wide and it weighs about 730 tons fully loaded. Tugs, winches or crawler tractors are used to move the ACT as it is not self propelled. Hovering height is four feet.



## on a

Fully loaded and with a towing force of 15 tons, the ACTs will have a sea speed of about 7 knots in calm water and 3 knots when the waves are up to nine feet high.

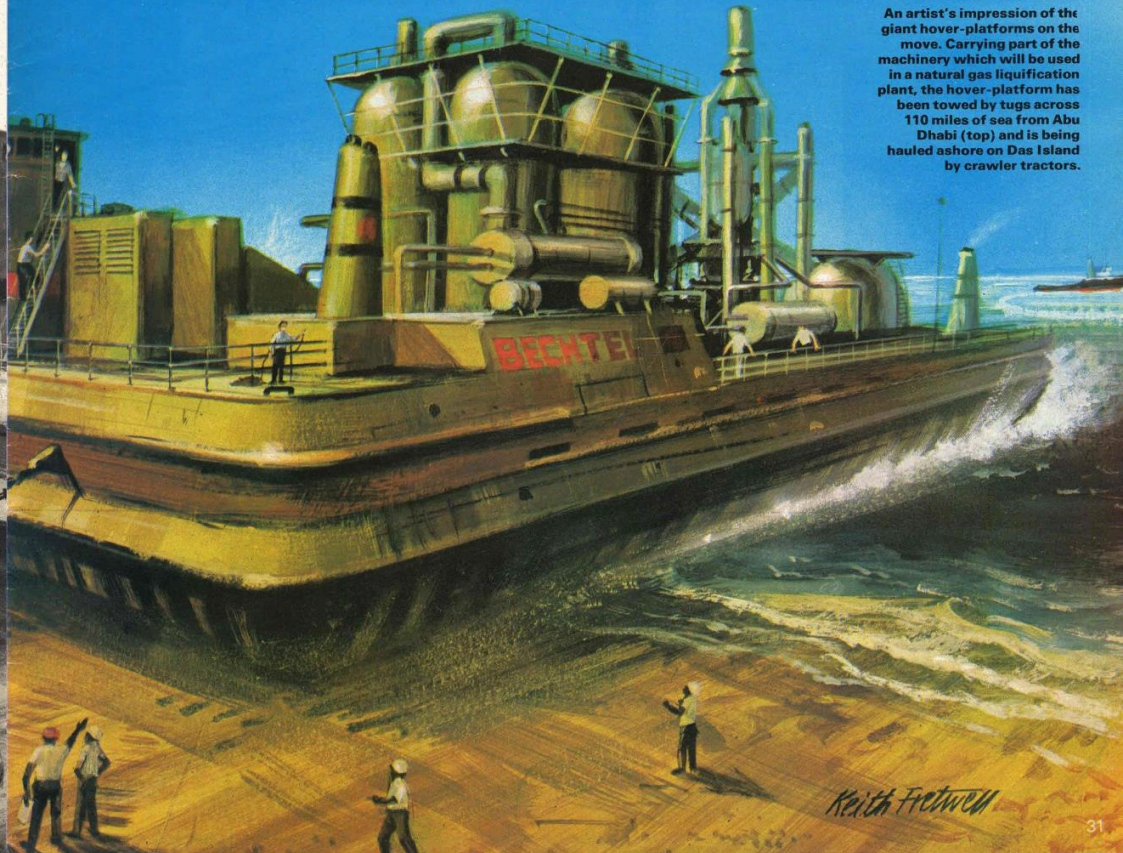
Two ten ton hydraulic winches are mounted on the bow to help load the plant sections while amidships there are two hydraulic capstans which are used for mooring, manoeuvring and anchoring.

As well as carrying the gas plant sections, the hover-platforms will be used to ferry supplies from ships anchored off Das, to the island. Each platform will have a crew of four and a ship's master.

These special ACTs are three times larger than anything else built by Mackley Ace, but already this unusual type of load carrier has proved itself invaluable in other fields. For projects such as drilling, surveying and salvaging they are ideal.



An artist's impression of the giant hover-platforms on the move. Carrying part of the machinery which will be used in a natural gas liquefaction plant, the hover-platform has been towed by tugs across 110 miles of sea from Abu Dhabi (top) and is being hauled ashore on Das Island by crawler tractors.



Keith Fretwell





## A Floating Railway

**A**MONG many floating oddities designed over the past hundred years, some have been commercially successful and carried out the task for which they were created. One such oddity was *The Leonard* built by the Birkenhead yard of Cammell Laird and launched on January 17, 1914.

She was truly a remarkable vessel. To the casual onlooker she appeared for all the world like a huge floating fairground railway. Railways was not far from the truth for she was primarily designed to carry two railway trains across the Canadian St Lawrence River between the cities of Quebec and Levis.

With a registered tonnage of 3,340, she had a steel hull 326ft long with a beam of 65ft. She was propelled by two sets of triple expansion steam engines that had boilers with huge tall power station-type funnels towering above the superstructure on each side of the hull. Not only was she unique in her appearance, but the fact that the St Lawrence River freezes each year meant *The Leonard* had also to double up as an ice breaker to clear a path for herself as she made the crossing in the winter.

The whole hull and deck were covered by a huge lattice work arrangement that supported a moveable platform carrying three railway tracks each 270ft long. The platform was capable of being moved up and down over a distance of about 20ft. This, together with its load, was raised and lowered by means of ten vertical lifting screws mounted along each side of the vessel. They were supported on columns within the lattice work array so that on berthing, the railway tracks could be raised or lowered to line up with the rail

terminus regardless of the state of tide, so that the trains embarking on one side of the river could disembark after their journey at a different height depending on the level of the water. To move the train, the weight of which could be as much as 1,400 tons, those lifting screws—similar to the working parts of a vice—required a great deal of power. They were driven by a special steam engine located below the main deck. The platform could move as much as 20ft and travel at the rate of one foot per minute.

It is perhaps interesting to realise that some of these trains were sleepers and while their passengers were tucked firmly in bed, the train would be moved aboard *The Leonard*, secured, lowered to a convenient posi-

tion and the ship set off on its passage across the icy wastes. Therefore, to ensure that warmth and comfort was maintained, special steam pipes were taken from *The Leonard's* boilers and fed into the heating system of the carriages.

Although a fantastic sight and considered by many a freak ship, she was no freak in her performance. *The Leonard* maintained a speed of 13 knots on her trials and in fact she crossed the Atlantic under her own power to Quebec to take up her duties on September 20, 1915.

She could carry one railway engine, two baggage cars and six coaches in one river crossing, or should it be purely freight, 15 box cars of the type large commercial carriers used on the North American Railroads.

*The Leonard* carried out her train ferry services until the Quebec bridge was opened in 1918. Her days were by no means over however. With Europe still engaged in World War I, she re-crossed the Atlantic to England once again in 17 days, and began ferrying war materials from Southampton to Cherbourg.

A new mooring dock with three parallel rails was built at Southampton plus a similar installation in the French port of Cherbourg. *The Leonard*, therefore, was probably one of the first cross-Channel train ferries to operate in the British Isles.

The service was finally wound up in 1919, but the terminal facilities were not dismantled until 1927. Nevertheless *The Leonard* still continued operating. She was converted to an oil tanker and provided useful service until finally being scrapped in 1932.

**Above: *The Leonard* was built specially for carrying trains across Canada's St. Lawrence River. In winter (right) she could smash through the ice of the frozen river. The tracks on board could be raised and lowered so that trains could be run back on to the main line.**





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10p Weekly No. 26 September 13-20, 1974

# **Speed** & Power

**SUPER  
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**EUROPE'S  
MULTI-ROLE  
AIRCRAFT**



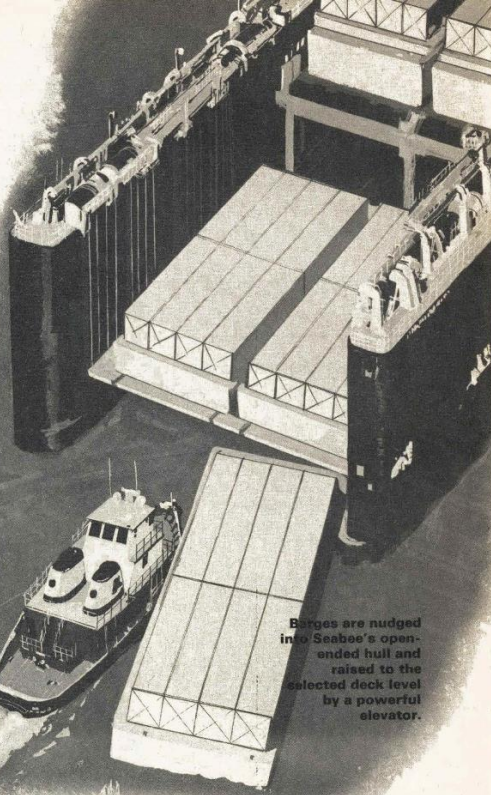
**CARS PLANES  
TRAINS SHIPS  
SCIENCE FICTION**



A SHIP with decks so long and clear that she could carry a complete moon rocket in one piece in her huge holds. A ship capable of carrying a whole armoured brigade, with its tanks, guns, fuel, ammunition, personnel and support vehicles, across the North Atlantic or to any trouble spot in the world. A cargo ship able to handle massive 2,000 ton loads in one lift and which can operate completely independently of any port. Each of these would be amazing virtues in any one ship, but all of these capabilities are to be found in the three great Seabees, giant barge carriers now busily running between America and Europe for the American

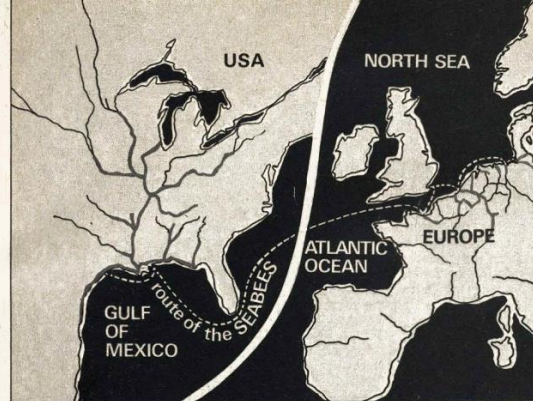
Lykes Lines. The largest dry cargo ships ever built in an American shipyard, each of the 875 feet long Seabees will carry up to 24,500 tons of cargoes in barges and has tankage sufficient for 30,000 tons of liquids.

The idea of the giant barge carrier comes from the trade that the New Orleans shipowners have long been engaged in. Cargo for their ships travelled by barges down the great American rivers of the Mississippi and Missouri to the Gulf of Mexico ports. Laboriously it was transferred from barge to ship and after the sea passage to Rotterdam or Antwerp it was slowly discharged by crane and teams of dockers into yet more



Loaded barges are towed toward a Seabee to be simply slotted into the ship in module form.

Barges are nudged into Seabee's open-ended hull and raised to the selected deck level by a powerful elevator.



barges for destinations along the Rhine and its tributaries. Time in port was excessively lengthy at each end of the sea voyage and it was becoming increasingly expensive.

Faced with these problems, Frank A. Nemec of Lykes Lines came up with a revolutionary idea — instead of loading the cargo into and out of barges — why not load the whole barge, cutting the time in port each voyage from weeks to only hours? From this simple concept was developed the design of the Seabees, among the most remarkable ships the world has ever seen.

Each Seabee is able to carry 38 specially designed box shaped steel barges which themselves are capable of loading 850 tons of cargo. Built strongly enough to

act as ships in their own right, the barges can ideally be joined together into long trains and then pushed by powerful tugs up the inland waterways from the port. The mother Seabee is unlike any other ship that has ever been built, a vast three-decked vessel with more than three and a half miles of single lane highway in her barge carrying spaces.

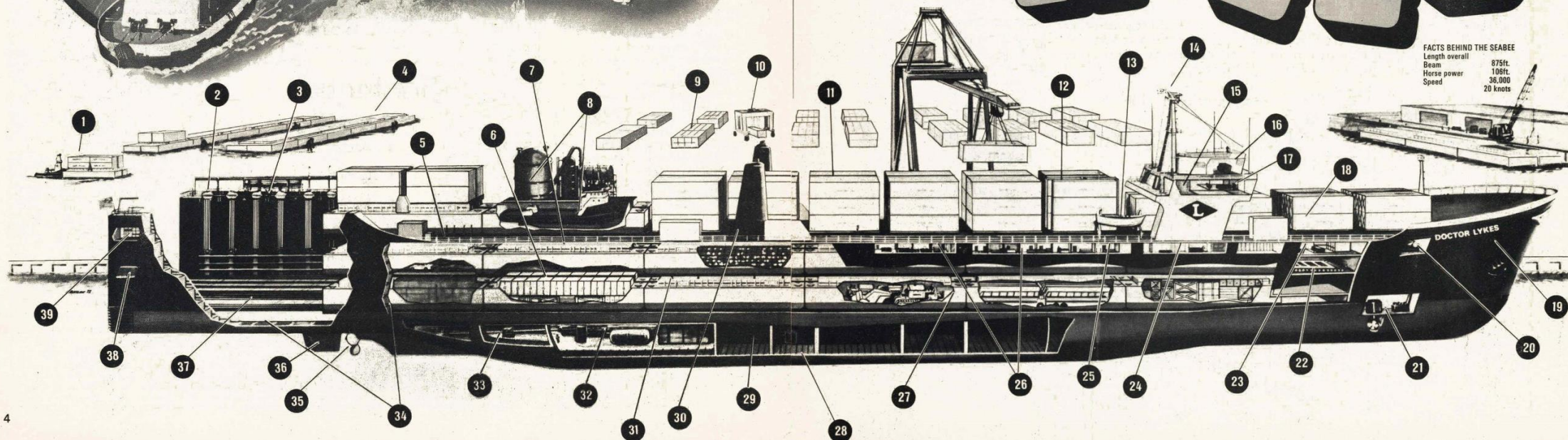
Cargo is loaded with an immense elevator at the stern which is able to handle 2,000 ton lifts in a single load, all controlled by one man. The elevator consists of a movable platform, hung from six giant hydraulic winches on the deck, and able to sink down into the sea under each pair of barges as they are pushed by tugs into the stern access. Once the barges are in position, the cargo officer sets the winches in motion and the elevator rises up under the barges, lifting maybe 2,000 tons at four feet a minute and safely bottoming the craft on steel blocks clear of the platform.

The cargo officer on a Seabee is a man with enormous power at his fingertips as he controls the loading operations. With a port-

CONTINUED ON NEXT PAGE

KEY TO CUT-AWAY DRAWING OF DOCTOR LYKES (below): 1 Loaded barge. 2 Elevator winches. 3 Barge positioning winches. 4 Barges. 5 Barge tie-downs. 6 30ft. long containers. 7 Fire detection equipment. 8 Heavy machinery on board barges. 9 Container storage. 10 Container carrier. 11 40ft. long containers. 12 20ft. long containers. 13 Lifeboat. 14 Navigation equipment. 15 Officers' quarters. 16 Wheel house. 17 Master's office. 18 40ft. long containers. 19 Hospital. 20 Crew's quarters. 21 Loaded Seabee barges. 22 Stabiliser tank. 23 Fuel tank. 24 Smoke stack. 25 Turbines. 26 32 Turbines. 27 Propeller shaft. 28 Salt water ballast tanks. 29 Propeller. 30 Rudder. 31 Submersible elevator, for barges. 32 Mooring port. 33 Elevator control room.

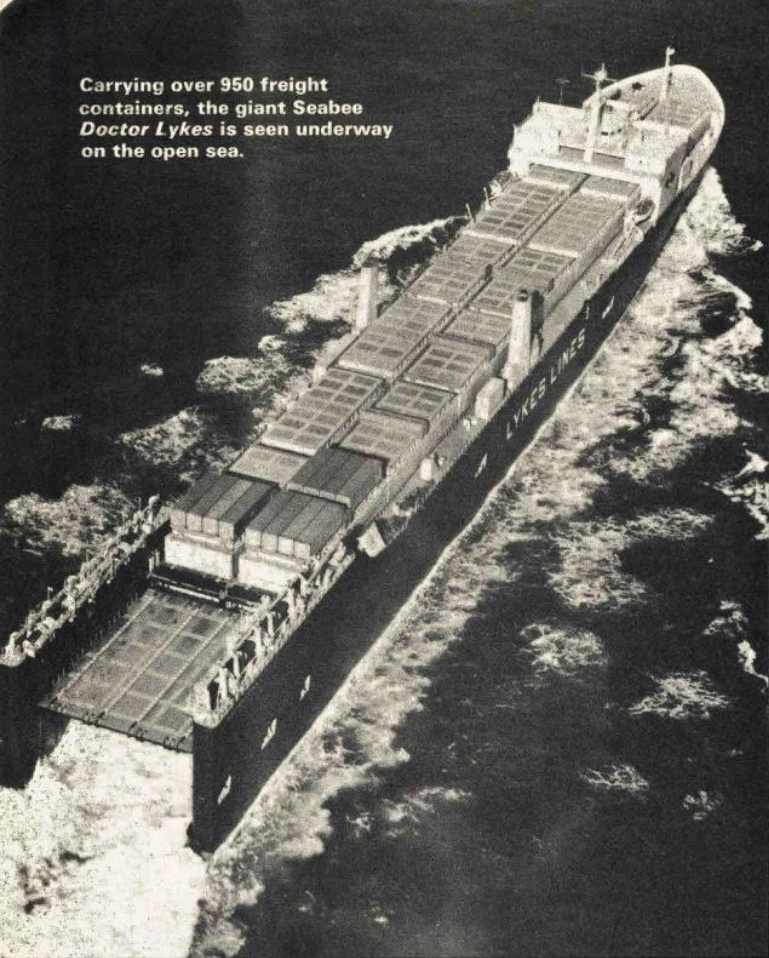
# SEABEES



FACTS BEHIND THE SEABEE  
Length overall 875ft.  
Beam 108ft.  
Horse power 36,000  
Speed 20 knots



Carrying over 950 freight containers, the giant Seabee *Doctor Lykes* is seen underway on the open sea.



able control console and linked to all parts of the ship with a short wave radio, he is able to move the massive loads swiftly around virtually by pressing buttons. A few words over the radio to the tug skipper standing by the mother ship and the tug pushes up two barges, nudging them into the huge access aft over the sunken elevator platform. Quickly checking that the barges are in their correct position, the cargo officer presses the elevator start button in his little hand-held console and with a deep hum the winches spring to life, raising the platform up under the barges. There is not even a falter as the colossal weight comes on the elevator and the two barges slowly rise dripping out of the water.

These two craft are destined for the middle deck and the cargo officer programs the system accordingly for the elevator to automatically stop at this level. He waits until the platform has aligned with the deck and then from the depths of the cavernous hold he summons up two huge multi-wheeled transporters to carry the barges away to their proper stowage. The transporters are remarkable machines in their own right, each being remote controlled and running on two pairs of rails that extend the full length of the ship on each deck. With a noise like giant trams, the two transporters roll out from the middle deck

driven by their hydraulic motors and disappear between the blocks under the barges. A hiss of the hydraulic fluid as 46 jacks act simultaneously to lift each of the 800 ton barges three inches clear of the blocks on the elevator. Slowly at first, then speeding up to walking pace, the two transporters and their massive loads trundle off into the depths of the ship. At a leisurely walking pace, the cargo officer follows. When the stowage position has been reached he sets down the barges on two rows of blocks and drives back the transporters for more. Meanwhile the elevator has been sinking back into the water and the tug is pushing up another pair of barges ready for slotting in. With heavy chains and wedges the Seabee seamen lash down the stowed barges to stop them shifting during rough weather.

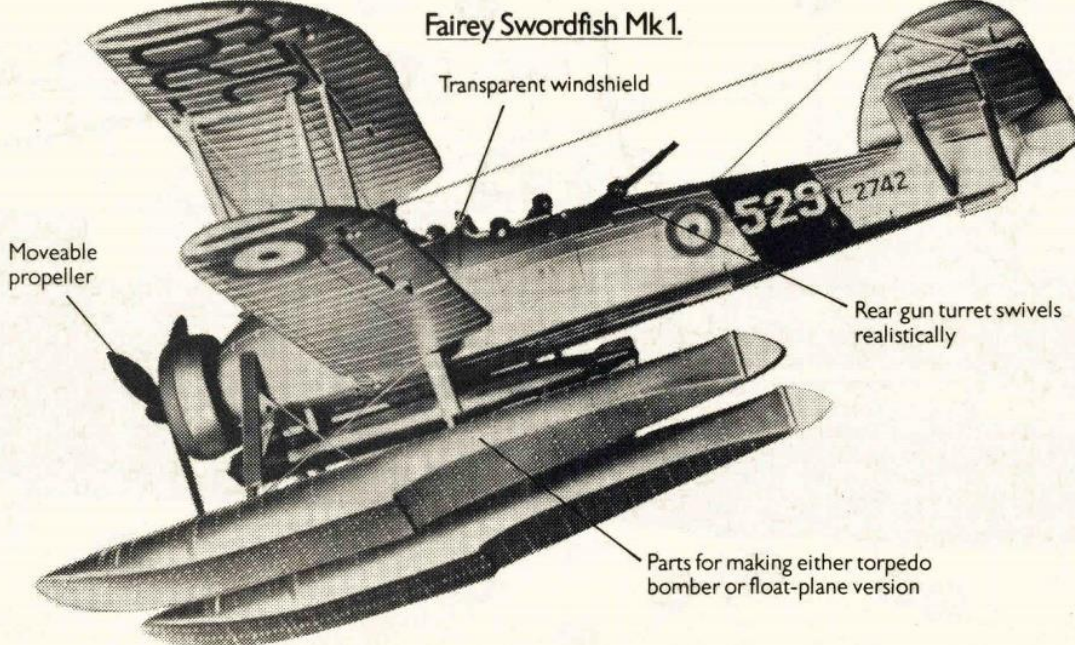
Truly amazing weights of cargo can be handled by the Seabees, which are able to steam across the North Atlantic at speeds of up to 20 knots, their huge single propellers being driven by 36,000hp steam turbines. It is in the performance in port however, where the Seabees really hum. Here a full load of 38 barges, with more than 20,000 tons of cargo inside them, can be loaded in just over twelve hours. This load would have taken a conventional cargo ship, using cranes and derricks, more than a week; slow compared to Seabees!

## YOU GET MUCH MORE MODEL WITH FROG

Scale Models magazine called the new Frog Fairey Swordfish Mk. 1 "the best 1/72nd kit of this aircraft ever to be produced!"

Like all Frog models, it's packed with superb details and features to give you much more model.

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WESTWOOD, MARGATE, KENT.





# POWER FROM THE SUN

High up in the Pyrenees—the mountains that separate France from Spain—a group of French scientists are working on a solar research station. Here they have created a furnace that produces metal-melting heat within seconds . . .



The incredible power of the Sun is demonstrated by this experiment in which a steel plate three-eighths-of-an-inch thick was burned through by the sun in 50 seconds at a temperature of 6,500 degrees Fahrenheit.

SCIENCE has a new sport—trying to catch sunbeams. It's based on an old idea going back through the centuries, perhaps as far as the ancient sun worshippers. These primitive people knew nothing about the Sun—it's nature, size or distance from the Earth. But they undoubtedly sensed that earthly life is completely dependent on it, and they made the Sun the most important of their many gods.

Today, in the Space Age, the game of catching sunbeams is

CONTINUED ON NEXT PAGE



being played in deadly earnest. With a global energy crisis on our hands, scientists in many parts of the world like those in the Pyrenees are striving to harness the power of the Sun in ways that were undreamed of only a few years ago.

Most of the energy we use at present came originally from the sun, of course. It is now stored in the form of coal, oil, water and wood. But exploding populations and escalating living standards have made great inroads into fossil fuel reserves. Some are already difficult to obtain and expensive to process. So a widespread search for alternatives is under way.

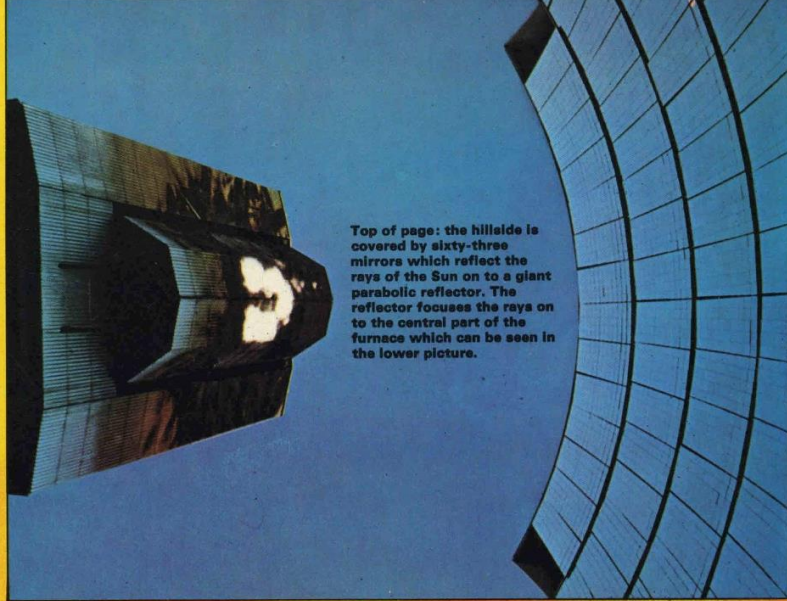
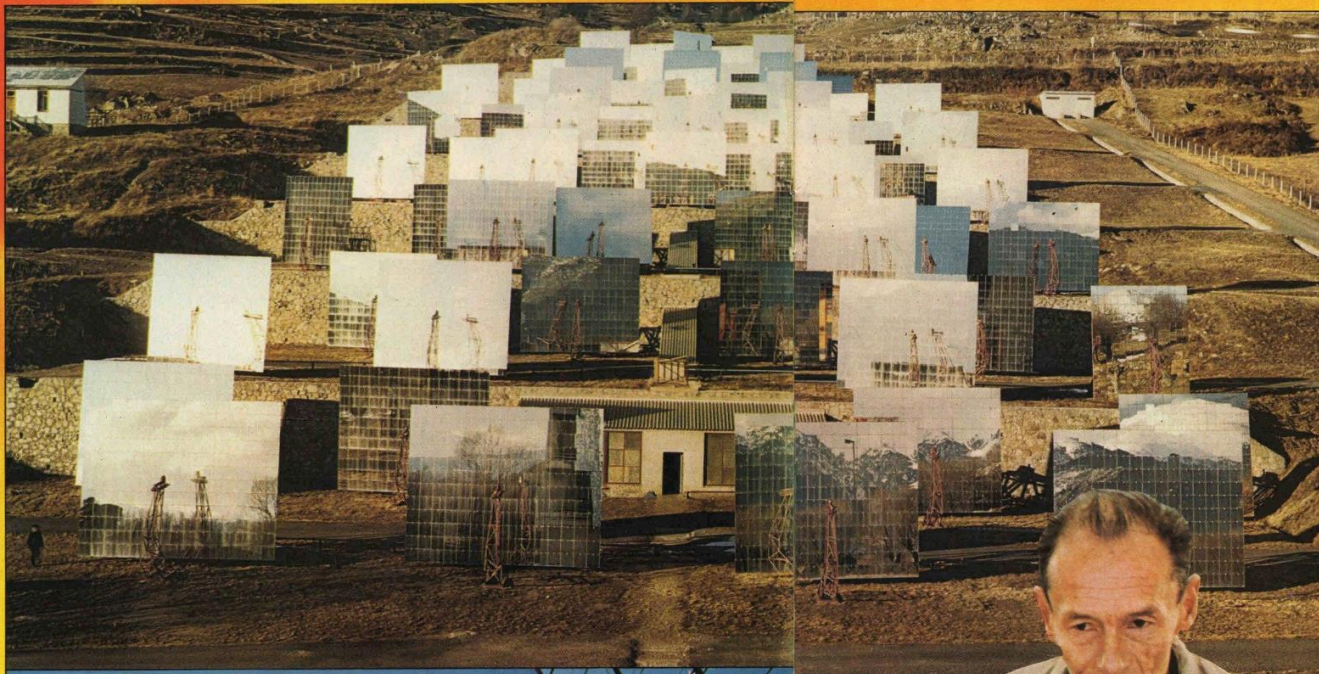
One interesting idea concerns sunbeams—or solar energy. Scientists want to capture and convert into usable power the inexhaustible supply of radiant energy that streams constantly from the Sun. Not thousands of years later when it is locked up in underground coal seams and oil deposits, but right now—at the moment it reaches Earth. If this could be done on a large scale we would have no more worries about power to run our factories and transport, or about heat to warm our houses and offices.

Note that we said "if," and it is still a very big "if." Although solar power is free for anyone to use, converting it in big enough quantities will be a colossal undertaking, both technically and financially.

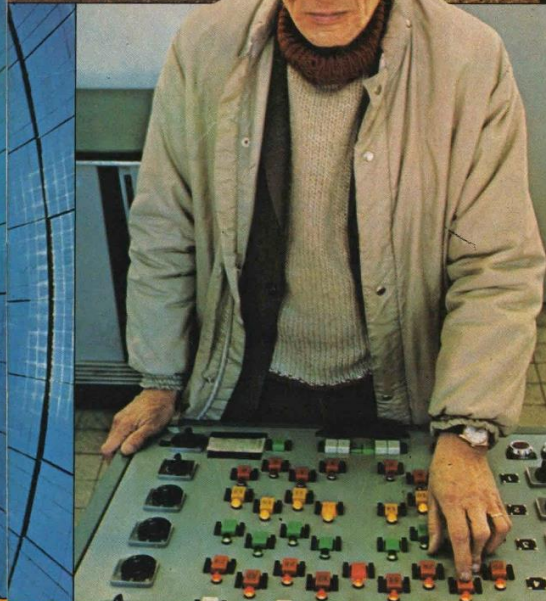
There are grounds of optimism, however. Modest attempts to use solar power have been going on for a long time, mostly in countries where other fuels are scarce. A water distillation plant powered by the Sun was built in Chile over a hundred years ago. During World War I, energy from the Sun was used to power a steam engine.

Since then there have been a few solar-powered cars and boats. Sunshine has also been collected and concentrated to power salt water conversion plants and light-house beacons.

In several parts of the world enterprising individuals have installed solar-powered heating systems, usually by mounting a simple type of solar collector on the roof. An experimental house, opened last summer at the University of Delaware, comes into this category. Called Solar One, it has two large panels of solar cells mounted on its roof. Just like the solar cells which provide the power for spacecraft, they produce electricity by chemical reaction when they are exposed to sunlight. Inside Solar One some of



Top of page: the hillside is covered by sixty-three mirrors which reflect the rays of the Sun on to a giant parabolic reflector. The reflector focuses the rays on to the central part of the furnace which can be seen in the lower picture.



Above: The enormous parabolic mirror has 9,000 facets which act like a magnifying glass and concentrate the Sun's rays into a tiny area of intense heat. Left: a scientist controls the ranks of mirrors on the hillside so that they can be kept facing the Sun in its apparent movement across the sky.

the electricity is used immediately to run radiators, lights and domestic appliances. The remainder is used to charge batteries which provide electricity at night.

Applications of this kind make only the minutest use of all the solar energy available. Although some of it is trapped by the Earth's atmosphere, enough gets through in two sunny days to provide us with as much energy as is stored in all our remaining reserves of coal, oil and gas. And Americans, who use about a third of all the world's energy, have recently been told by experts that the surface of Lake Erie (one of the Great Lakes) would receive more energy from the Sun each day than the United States consumes in a year!

One drawback is that energy from the Sun is low in density, and

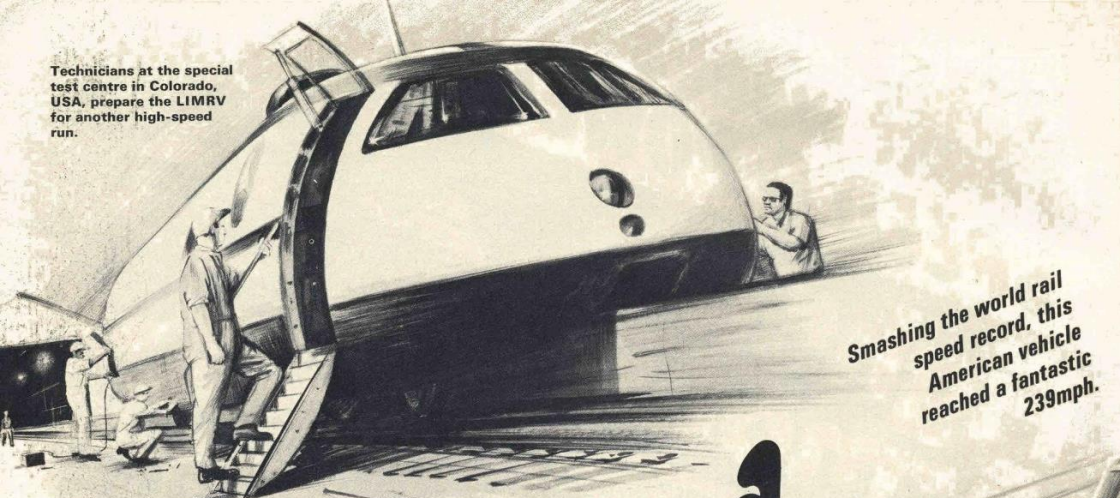
the amount that can be collected economically in one spot is limited. This has sparked off some imaginative ideas like the 'solar farms' which one scientist wants to build in the Arizona desert. These would have sunshine collectors, looking like futuristic greenhouses, dotted over 5,000 square miles of desert. The collected sunshine would be stored in molten salt, which would act as huge natural batteries, until it was needed for steam generation.

The French solar furnace is ten times more powerful than anything in America, but is used mainly for research into the fusion of mineral oxides.

An even more way-out idea is for a series of solar power stations operating in space. These would be giant satellites fitted with wing-like structures several miles square. The wings would be covered with solar cells that would turn the sunlight into electricity, which in turn would be turned into microwaves for transmission to Earth. A 1,200-ton satellite of this type would have to be taken into space in pieces and assembled in Earth orbit, but would be able to produce enough electricity to supply most of Britain.



Technicians at the special test centre in Colorado, USA, prepare the LIMRV for another high-speed run.



Smashing the world rail speed record, this American vehicle reached 239mph.

# Record On Rails

**S**CREAMING across a peaceful stretch of prairie in the American state of Colorado earlier this year, a strange looking vehicle shattered the world speed record for a railway vehicle by travelling at 234mph on a special six mile test track.

The record, set up in April, was broken again the following month by the same vehicle which reached an amazing 239mph.

The vehicle was built not just to break records. It has two purposes; firstly to test a type of motor which is almost certain to drive passenger carrying vehicles at speeds of over 200mph in the next few years, and secondly to find out how conventional two-rail tracks and flanged wheel railway vehicles behave at these high speeds.

The special motor is called a Linear Induction Motor. It has no moving parts but consists of two main sections. The complex system of coils and other components carried on the vehicle and an aluminium plate fixed to the ground all the way along the track. When electric power is applied, the coils produce a terrific magnetic force which pulls the vehicle along the aluminium plate; a force so strong that it can easily pull vehicles along at speeds of 300mph.

The test vehicle which broke the record is called the Linear Induction Motor Research Vehicle or LIMRV for short. It weighs about half as much as a railway passenger coach and contains, under the special low drag aluminium skin, a 3,000 horsepower gas turbine

which drives the electric generator feeding the electricity to the motor. It also houses fuel tanks, a driver's compartment for testing up to 100mph and the complex radio control gear to enable the vehicle to be driven from the central control room. LIMRV runs on two four-wheel bogies like those to be seen under the ends of a passenger coach, and steel rails like those used on main line railways.

LIMRV's noisy gas turbine, used to generate electricity, is only used to simplify operation of the research vehicle. The almost silent linear motors which would be used in a passenger carrying system would collect their electric power from wires alongside the track.

Before the record breaking run the vehicle's speeds had been slowly increased in steps of a few miles per hour. After each run the measurements obtained were checked by computer and a decision made whether to increase speed, in case there was any chance of the vehicle running wild and coming off the rails at the next speed step.

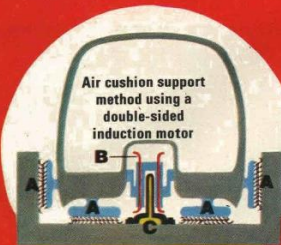
## BRITISH RAIL HELP

The scientists responsible for this work were in fact from British Rail's Railway Research Centre at Derby. They had been invited to help and were flown over because of their knowledge of how railway

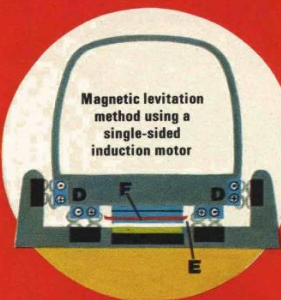
vehicles behave when they run at very high speeds. They had learnt all about this when doing the basic research for the Advanced Passenger Train being developed in Britain.

British Rail's scientists were very happy to help in this exciting project because they had calculated some years ago that railway tracks and vehicles similar to the ones being used today could in fact carry traffic at speeds around 250mph. It was only now that their ideas could be proved with real equipment.

Record breaking runs like this are likely to become everyday events at the £30million High Speed Ground Transportation



Air cushion support method using a double-sided induction motor



Magnetic levitation method using a single-sided induction motor

Top of page and above: The two methods that could be used for guiding the LIMRV, both using linear induction motor propulsion. A. Air cushions. B. Motor windings. C. Vertical reaction rail. D. Magnetic levitators. E. Motor windings. F. Horizontal reaction rail.

The LIMRV is built of lightweight aluminium and weighs 22 tons. A 3,000 horse-power gas turbine provides power for the linear induction motor. Driver space is provided, though the vehicle is driven by remote control above 100mph. KEY TO CUT-AWAY DRAWING: 1. Induction motor reaction rail. 2. Truck assembly. 3. Electronic system. 4. Air intake. 5. Two disc brakes per axle. 6. Alternator. 7. Linear induction motor. 8. Gas turbine. 9. Exhaust. 10. Rear truck assembly. 11. Fuel tank.



Below: The Research Vehicle picks up speed for a fast dash through the American prairie.



Centre which the Americans are setting up on 52 square miles of desert-like country which is planned to become to Earth transport systems what the famous Cape Canaveral is to trips into space.

The LIMRV is only one of a number of unusual vehicles being tested at the Centre. On a three-mile long concrete guideway, a jet powered Tracked Air Cushion Research Vehicle is being put through its paces.

This 51-foot vehicle which looks like an aeroplane without wings hovers just above the guideway whilst jet engines blast it forward. When the jets are replaced by Linear Motors this

vehicle could well be used to link American cities at speeds of 300 mph which will help to solve many of the problems that are caused at the moment by overcrowded airline routes. The present track is now being extended so that testing can take place over a 23mile run.

## NEW EQUIPMENT

Just as important, although less exciting, is the work going on at the Centre to improve existing railway equipment and performance. America has thousands of miles of under-used railway which can be improved with new equipment. One of the busiest tracks at

the centre is a nine-mile circle of rails. On this, commuter and underground type trains can chase their own tails for mile after mile whilst information is obtained about their running.

When the High Speed Ground Transport Centre is finished, and all the tracks and laboratories are in full swing, the aim is to provide equipment to operate three types of transport system. Super railroads where 150mph freight trains run over existing tracks. 150mph passenger express trains for long distance runs and 200—300mph transport links between major cities where traffic levels will be very high. It may not be long before the rail speed record is broken again!



**FREE** COLOUR WALLCHART OF FIGHTING ARMOUR  
**INSIDE!**

10p Weekly No. 27 September 20-27, 1974

# Speed & Power

**LIFE  
ABOARD  
THE QE 2**



**PLANES  
SPACE CARS  
SCIENCE FICTION  
SHIPS**

**BEWARE THE BEARS**





# Twister and Dragon Wagon

**T**RANSMISSION whining, the long low vehicle races along a forest track, its way barred by a pile of rubble. Changing down, the driver touches the brakes and the eight-wheel "mini-tank" checks slightly, but keeps right on towards the obstruction. Instead of swerving away, it goes straight up to the rubble heap—and proceeds to climb it in a cloud of dust!

Over the top, down the other side and away it goes. Skidding sideways, the weird vehicle zooms down a dip in the dirt road and

plunges straight into a river!

All this is not a dramatic scene from the latest James Bond film, but a typical test by the United States Army for the "Twister", an amazing, go-anywhere vehicle designed by Lockheed Aircraft Corporation.

Most readers of *SPEED & POWER* are familiar with the famous Starfighter, Hercules, U-2 and Galaxy aircraft developed by Lockheed, but few may realise that Lockheed also has a number of other important divisions. These include the Missiles and Space

Company, which is responsible for developing the Polaris, Poseidon and Trident missiles, the Agena spacecraft, and the Twister series of high mobility vehicles.

The story of the Twister can be traced back to the early 1960s when Lockheed carried out a series of computer programmed war games for the US Army.

These games covered campaigns in Korea, the Middle East and Europe—all areas in which the US Army could become involved in a conventional or nuclear war. According to Lockheed,

the games showed that future military vehicles must have even better mobility and higher performance than those at present in service.

Lockheed then began the development of the 8×8 Twister high mobility vehicle.

The Twister consists of two bodies, each with four wheels. These are joined by a pivotal yoke which allows the vehicle three degrees of freedom in pitch, roll and yaw. It is powered by two Corvair engines, one in each body, and an automatic transmission is fitted. All eight wheels are pow-

**It's the Twister—American vehicles which go anywhere!**

**Left: The first Lockheed Twister pictured during a typical rough country test on behalf of the US Army. Below: An amphibious Twister emerging from a river.**





ered, the front four having individual suspension, the rear ones being mounted in pairs on "walking" beams.

The Twister has an exceptional cross country ability and a top road speed of 65mph, and can accelerate from 0 to 30mph in 5.6 seconds. Basic overall dimensions are: Length 18ft. 4in.; Height 6ft. 10in.; Ground Clearance 1ft. 6in.; Loaded Weight 16,570lbs. This data relates to the Twister 06 testbed.

The first prototype Twister was completed on schedule in October 1965 and was immediately subjected to three months vigorous tests. Early in 1966, further trials were carried out in snow, mud, sand and rice paddies and later came more tests in Alaska and Nevada.

Lockheed demonstrated this prototype all over the United States and in January 1968, the Army finally awarded a contract worth over three million dollars for the construction of three Twisters.

These were to be single examples of the standard, amphibious and armoured models. By 1971, all of them had been built and delivered to the Army. They were then given further tests.

Although no production order for Twisters has yet been made, the three vehicles proved the basic concept and have led Lockheed to develop two more, the Dragon Wagon and Scout.

The Dragon Wagon is a big, 8x8 truck, designed to transport cargo over all types of terrain in all weathers. It is powered by a Caterpillar engine which develops 225hp at 2,800rpm and has an Allison gearbox with one reverse and five forward gears. To help the driver, hydraulically-boosted steering is provided.

The driver's cab is of all steel construction, and among the many useful items fitted for him are tinted windows, heated rear view mirrors, seat belts and, as usual on American vehicles, a cigar lighter!

The basic vehicle is 25ft. long, 8ft. wide and 9ft. high. It has a top road speed of 56mph, can climb a near-vertical gradient and ford a



river or stream up to 45ins deep.

As with most vehicles of this type, it is rather thirsty and its fuel tanks hold 95 gallons. Fully loaded, the Dragon Wagon weighs 20 tons, and ten tons without any cargo.

Initial production of the Dragon Wagon has started and if any reader is interested in buying one,

he will have to find around 70,000 dollars!

Lockheed expect that this vehicle will be used in areas with poor communications, especially Arctic and desert regions. It has both civil and military applications and a wide range of "bodies" can be fitted to the basic vehicle, so that Dragon Wagons can be used

as fire-fighting units, drilling platforms, concrete transporters and container carriers. Wheel or sledge-type trailers can be hitched on to the back of the vehicle, if required.

The Lockheed Scout is the firm's entry for the valuable Armoured Reconnaissance Scout Vehicle contest. Lockheed have built and delivered to the Army four of these Scouts under a 12.3 million dollar contract awarded in May 1972.

The Scout is a 6x6 high mobility vehicle designed for reconnaissance duties and fulfilling much the same role as the British Light reconnaissance Scorpion tank.

The Scout is powered by a 300hp turbo-charged diesel engine which gives it a top road speed of at least 65mph. It is fully amphibious, being propelled in the water by water jets. It is armed with a 20mm cannon and a 7.62 machine gun and, as with most modern armoured fighting vehicles, a full range of night fighting aids is fitted.

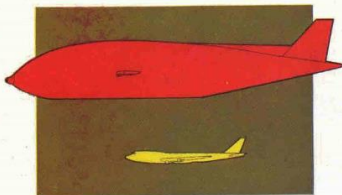
**Above: The civil Dragon Wagon hauling a heavy trailer load. Note how the independently-sprung wheels ride over the bumps so that the trailer stays level. Below: Mud, sand, gravel or hills, its all the same to Dragon Wagon. Here it ploughs through mud which would bog down a conventional vehicle.**



**Below: These three pictures show the advantages of a high-mobility vehicle. This Twister finds a three foot wall no problem at all. Should it need to defend itself or make an attack, the Twister can take a 20mm cannon in a low profile turret. Top speed is 65mph.**



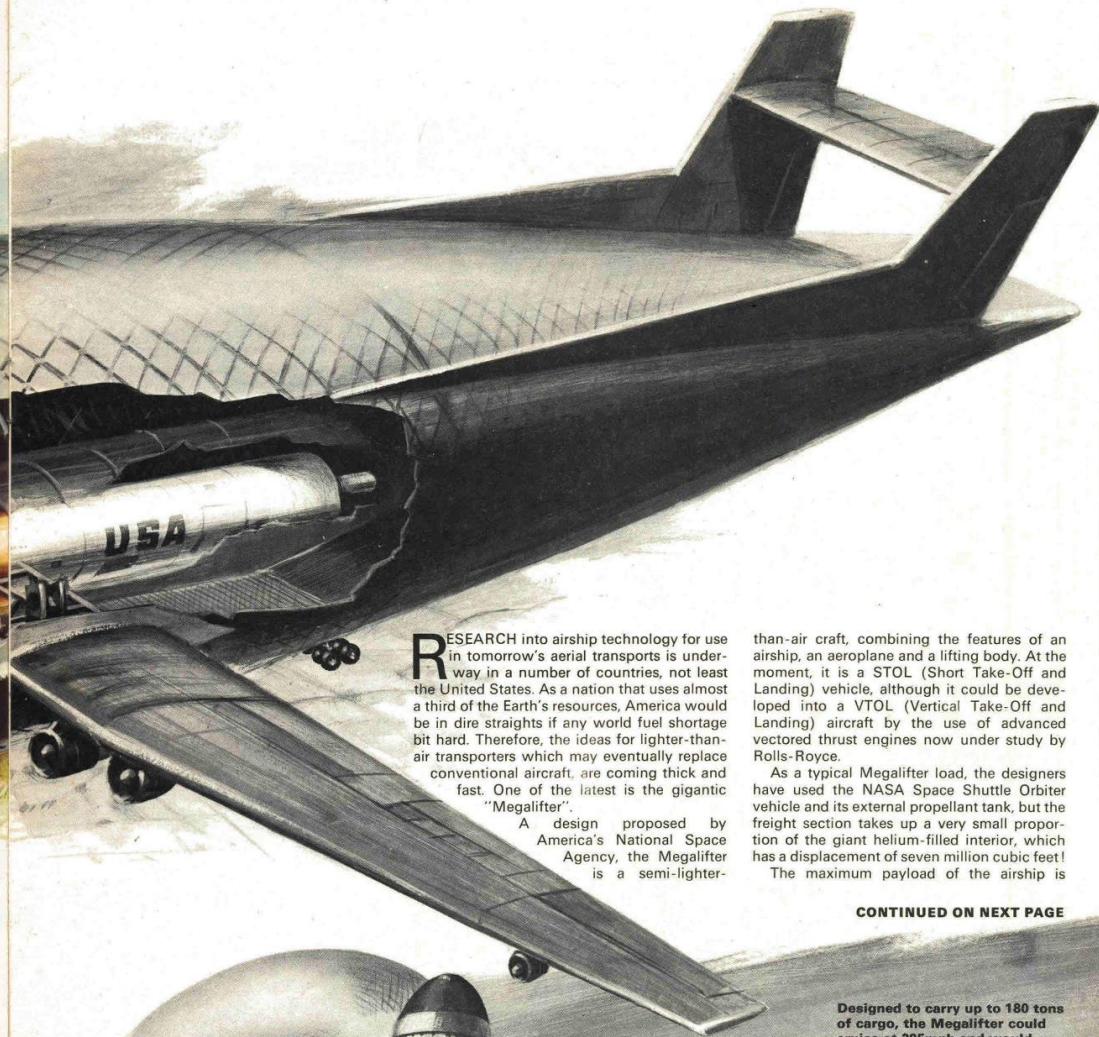




Below: A cutaway of the proposed Megalifter with its huge 40 foot square by 300 foot long cargo compartment, easily able to swallow a payload like the space orbiter shuttle and its external fuel tank shown here. Such a load would be taken in through the craft's belly and hung on cargo hooks—hence the absence of a floor in this version of the Megalifter! Left: This scale drawing shows just how big the Megalifter could be—dwarfing a Jumbo jet.

# MIGHTY MEGALIFTER

If plans now being considered in the United States of America come to fruition, a real super-giant of the skies—about ten times the size of a Jumbo Jet—may soon be thundering its way across the North Atlantic.



RESEARCH into airship technology for use in tomorrow's aerial transports is underway in a number of countries, not least the United States. As a nation that uses almost a third of the Earth's resources, America would be in dire straights if any world fuel shortage bit hard. Therefore, the ideas for lighter-than-air transporters which may eventually replace conventional aircraft, are coming thick and fast. One of the latest is the gigantic "Megalifter".

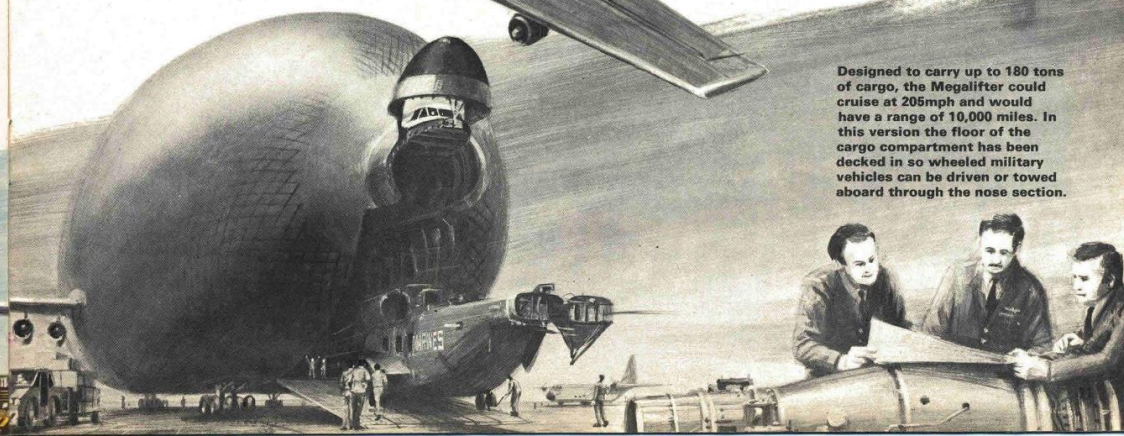
A design proposed by America's National Space Agency, the Megalifter is a semi-lighter-

than-air craft, combining the features of an airship, an aeroplane and a lifting body. At the moment, it is a STOL (Short Take-Off and Landing) vehicle, although it could be developed into a VTOL (Vertical Take-Off and Landing) aircraft by the use of advanced vectored thrust engines now under study by Rolls-Royce.

As a typical Megalifter load, the designers have used the NASA Space Shuttle Orbiter vehicle and its external propellant tank, but the freight section takes up a very small proportion of the giant helium-filled interior, which has a displacement of seven million cubic feet!

The maximum payload of the airship is

CONTINUED ON NEXT PAGE



Designed to carry up to 180 tons of cargo, the Megalifter could cruise at 205mph and would have a range of 10,000 miles. In this version the floor of the cargo compartment has been decked in so wheeled military vehicles can be driven or towed aboard through the nose section.



estimated at 400,000 lbs (178 tons), the cargo being accommodated in a section 40ft. square by 300ft. long.

Studies into the practical use of Megalifters are being conducted by NASA's Ames Research Centre, and they include a 12-month exploration of the possibility of the lighter-than-air vehicle and its potential role in future transport systems.

Firstly, there will be an investigation into airship technology, followed by the tendering of a contract to manufacturers, who will complete detailed studies.

Although in the past helium gas has proved to be less than successful in airship design, the Megalifter will use it primarily to offset a large proportion of the total airframe/loaded weight on take-off.

The use of a 530ft. span high lift wing and four General Electric TF39-GE-1 engines developing a total 164,400 pounds of thrust would enable the Megalifter to take off and land in a short distance. Supplementary control—needed if the craft loses an engine on take-off or meets turbulent conditions—is

provided by two vectored thrust engines on the wingtips.

If you thought that the Jumbo Jet was large, you'll find Megalifter will be enormous! Its overall length is 650ft. and the height to the tips of the twin "V" tail is 145ft. The width between the main landing wheels is 80ft.

The helium envelope has a lightweight geodesic framework in a lifting body shape. The structural members will be filled with foam or fibre glass stiffeners.

When it takes off, the Megalifter will obtain lift from the large wing and fuselage—enough to raise the helium-filled envelope. As the craft accelerates and climbs, the gas loses buoyancy, but this will be overcome by the fuselage itself, which has enough "self lift" once it is actually in the air. Maximum ceiling of the craft is put at some 15,000ft.

Although it would be the biggest craft yet seen in the skies, the Megalifter is basically a simple design. Its wing carries through the fuselage and is attached to the top of the cargo compartment for added strength, with the vertical and horizontal tail surfaces at the back.

**Fitted with advanced vectored thrust engines, now under study by Rolls-Royce, the Megalifter could have full Vertical Take-Off and Landing ability, enabling it to take-off from a space little larger than the craft's own dimensions.**

Up front will be the crew and cockpit module which, to save time and the expense of designing a new one, will probably be taken from a giant Lockheed C-5A Galaxy military transport. It will comprise the first 15 to 20ft. of the Galaxy's front fuselage, which contains the controls, the computer system, sleeping area and landing gear units.

Two types of material are under study for the Megalifter's external skin: Goodyear Aerospace is proposing a self-sealing skin, and LIC Industries a "weaved" lightweight covering, able to withstand pressures of 15lb per square inch, the maximum the Megalifter is expected to encounter during a climb to altitude.

When the craft is on the ground, the helium cells would be held at low pressure, usually the minimum to keep the required hull curvature.

The GE TF39 engines planned for the Megalifter are also taken from the C-5A and are mounted close in to the wingroot. Each outer powerplant is set back slightly, allowing for access to maintenance panels.

Due to the great distance of the flying control surfaces from the cockpit, a "fly-by-wire" system will be used. A combination of spoilers and ailerons will be used for the wings, along with leading edge slots and flaps for high lift performance. Take-off speed of the Megalifter is expected to be around 70mph.

If and when this huge craft is ordered, the Megalifter Co. would form an engineering group to direct the project. It is estimated that full scale development of the craft would take about five years.



# MIGHTY MEGALIFTER



**FREE  
INSIDE!**

# COLOUR WALLCHART OF WARSHIPS

10p Weekly No. 28 September 27-October 4, 1974

# Speed & Power

**AIR-SEA  
ASSAULT  
FORCE**

**THUNDERBOLTS  
FROM THE SKY**

**CARS  
SPACE  
TRAINS  
SPEEDWAY  
SCIENCE FICTION**





Right: An artist's impression of Explorer 42 orbiting the Earth. It is the first American satellite to be launched by another country and is designed for X-ray astronomy in space.

The photograph in the centre of the page shows an engineer attaching gold-plated contacts to a lightweight mirror for the ultra-violet telescope of the Orbiting Observatory.

IF YOU were asked to guess where the most exciting scientific discoveries will be made between now and the year 2,000, you would probably guess "space". And the chances are you would be right. Some scientists would go further, however, and nominate a particular area of research in space. They would single out astronomy as the science with a golden future.

But, you may ask, isn't astronomy one of the oldest sciences? Optical astronomy is, of course, but radio astronomy is one of the youngest sciences. Both branches of astronomy have the benefit of sophisticated new tools in the continuing quest for knowledge of

Below: Technicians working on the OAO-2 (Orbiting Astronomical Observatory), the largest and most complex automated space-craft.

the origin and structure of the universe.

Computers are now used to point telescopes with precision at celestial targets. They are also indispensable in sifting and processing the enormous amount of data that has recently become available on our own solar system and on the millions of star systems farther out in space.

Newly-developed sensing instruments that can detect extremely faint energy sources, modern ceramics developed for the space programme and the science of cryogenics (ultra-cold) are all employed to improve the performance of powerful telescopes.

Add a real bonus from the space age: orbiting satellites that can carry telescopes and other sensing instruments above the distorting effects of the Earth's atmosphere, and you can see why astronomy is all set for a new lease of productive life.

Over the past three or four centuries optical astronomers have pieced together the life history of stars—how they are born from huge clouds of swirling gases; how they evolve through a series of nuclear transformations; and how, after building up heavier and heavier elements over millions of years, they finally collapse and die to become, as one scientist has put it, "clinkers on the stellar ash heap".

Optical astronomers have also made extensive studies of galaxies that exist beyond our solar system. They have given us a picture of a universe of such enormous size that we can scarcely imagine it, with millions of galaxies all speeding away from us at fantastic speeds.

Radio astronomy, now just over 40 years old, began when an

American engineer discovered by accident that radio waves were reaching Earth from outer space. At first astronomers could not connect these radio waves with any known object in the sky, but later as bigger telescopes were built, it became possible to identify some of the radio sources.

Now it is realised that the twinkling points of light we call stars are also potent sources of energy of different kinds—X-rays, gamma rays and radio waves.

Not all stellar objects emit visible light, however, and some of them can only be detected by instruments carried into orbit or by the big radio telescopes on earth. Among the many new objects discovered in the heavens during the past decade some had been predicted, but others were totally unexpected.

Among the surprising discoveries are the fast-spinning pulsars, first located in 1967. They

send out radiation at precisely-timed intervals, and are thought to be remnants of stars that have collapsed and been condensed by gravitational sources into small, unbelievably dense bodies.

Quasars also took astronomers by surprise. They appear as very faint stars when photographed by powerful optical telescopes, but send out enormous amounts of radiation. After 10 years of study quasars are still a mystery. Some astronomers think they are among the most distant objects in the universe. Others are less certain. All agree that we need to learn a lot more about them.

Britain's famous steerable dish at Jodrell Bank is one of the large radiotelescopes throughout the world which have done pioneering work on radio sources. Another is the radar/radiotelescope at Arecibo in Puerto Rico—a fixed instrument which occupies a 20-acre depression between two

mountain ranges. This large reflector gathers faint signals from outer space and directs them to a receiver suspended above the ground.

It seems likely that in the next decade Earth-orbiting satellites will play a much bigger role in helping astronomers to solve the mysteries of stellar objects and gain a better understanding of the origins of the universe.

The United States already has two Orbiting Astronomical Observatories equipped with a range of instruments and experiments that includes a 36-inch telescope. Both are remotely-controlled from Earth and can, on a radioed command, single out and train their instruments on one specific star from among the millions available to their star trackers.

These observatories, operating outside the energy-absorbing "frosty window" of the Earth's atmosphere, are checking on the age of stars by measuring their mass and the rate at which it is being converted into energy.

One of the most productive astronomical satellites has been the midjet Explorer 42, which was launched at the end of 1970 from a platform in the Indian Ocean off the coast of Kenya. In its first two years of operation this little American satellite identified over 200 X-ray sources, including several X-ray pulsars—a special form of neutron star found only in double star systems in which two stars revolve around a common centre of gravity.

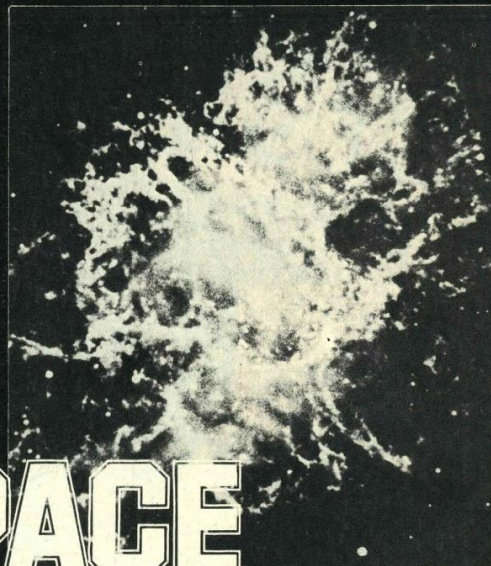
Explorer 42—which is now generally known as Uhuru (the Swahili word for freedom)—has also located two mysterious sources of X-rays in the constellation The Swan which astronomers think could be "black holes".

A black hole—first forecast by Einstein in his Theory of Relativity—is a star that has collapsed to such densities that neither matter nor energy (in effect, no light) can ever escape from it. Material being drawn into such a black hole could, some scientists think, produce enormous amounts of radiation.

But if black holes can't be seen by optical telescopes how will their existence ever be verified? The answer at present seems to be, perhaps, eventually, through their effects on other celestial objects.

This is one, but only one, of the many absorbing questions that modern astronomy hopes to answer as the space age develops.

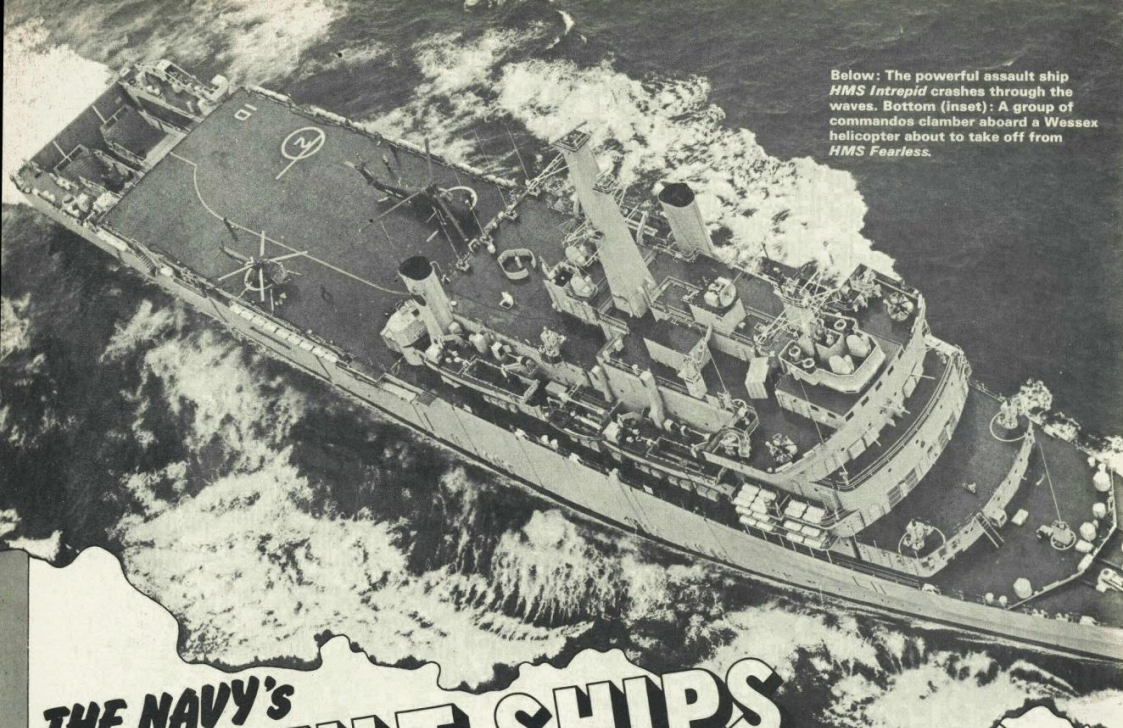
# TELESCOPES IN SPACE



Above: The Crab Nebula, the remains of a colossal star explosion, was the first celestial body of its kind to be identified by astronomers. The body was discovered in 1669, and is known as a "pulsar" sending out regular pulses of light and radio signals.

Key: 1, Telescope aperture, 2, Sun Shutter, 3, Balance Boom, 4, Solar Panel, 5, Star Trackers.





Below: The powerful assault ship *HMS Intrepid* crashes through the waves. Bottom (inset): A group of commandos clamber aboard a Wessex helicopter about to take off from *HMS Fearless*.

# THE NAVY'S ASSAULT SHIPS

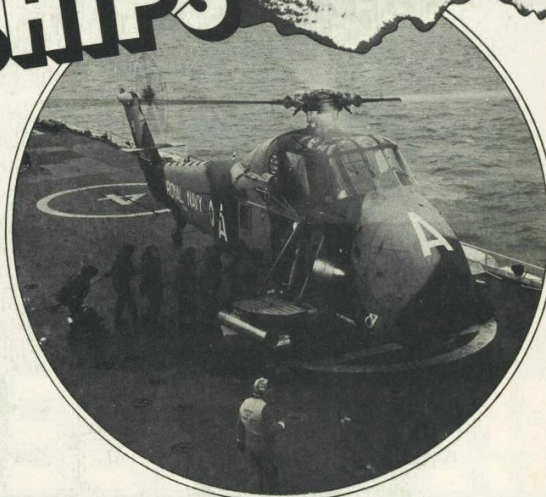
THE DESIGN for *HMS Fearless* and *HMS Intrepid* is so good that America has decided to build five similar vessels on a much larger scale, designed to give the US Marine Corps and US Navy the greatest versatility in their histories.

The *Fearless* was the most versatile ship ever designed for amphibious warfare and together with the Commando ships formed a powerful, highly mobile, assault force. She is really a floating dock with a large helicopter platform from which up to four helicopters can operate. The dock at the stern can be flooded to float out large tank landing craft which are ready-loaded and waiting to roar into action when the stern gate is lowered. Vehicles, armour and equipment needed to maintain the force ashore can be stored on three deck levels.

The flight deck, which is 175 feet by 75 feet, can operate all types of helicopters including the Wessex 55, the Navy's largest troop carriers which can operate in pairs with 28 fully armed troops in each. A radar controlled approach system is fitted for night and bad-weather flying. When not in use the flight deck can be used for storing more vehicles.

Each of the two assault ships can carry a Royal Marine Commando or troops of an infantry battalion, and land them by helicopter or personnel landing craft — each taking 30 troops.

The main superstructure houses the operational headquarters, accommodation and offices. In amphibious operations the Naval and Military Commanders can control the entire assault with powerful communication systems to maintain close liaison with other



ships, helicopters and the troops ashore. The amphibious detachment made up of soldiers, Marines and sailors, is controlled by a Major, Royal Marines, and consists of the Landing Craft Squad-

ron, Beach Unit and Vehicle Deck party. These are the sections responsible for landing and supporting troops ashore, made up of men from six different corps or services, operating jointly.



Top row: Men at work on board *HMS Fearless*—left: The electrical control room which regulates all the ship's circuits. Top centre: Engines slow ahead! The engine room. Top right: The captain gives orders through the intercom system on the bridge. There are over 530 men on board assault ships like this, plus over 42 officers. Men are experienced in many trades, making the ships almost self-sufficient.



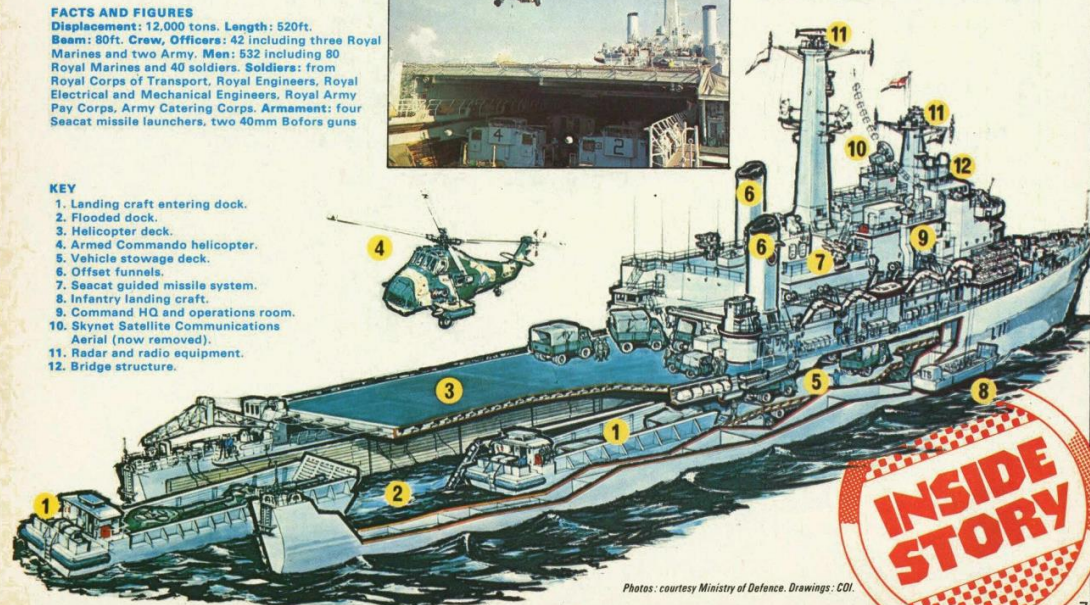
Above left: A troop landing craft in action. Above: A heavy landing craft loaded with Army tractor-shovels. Below left: A Wessex chopper and *HMS Fearless*; note the landing craft docked inside.

## FACTS AND FIGURES

Displacement: 12,000 tons. Length: 520ft. Beam: 80ft. Crew, Officers: 42 including three Royal Marines and two Army. Men: 532 including 80 Royal Marines and 40 soldiers. Soldiers: from Royal Corps of Transport, Royal Engineers, Royal Electrical and Mechanical Engineers, Royal Army Pay Corps, Army Catering Corps. Armament: four Seacat missile launchers, two 40mm Bofors guns

## KEY

1. Landing craft entering dock.
2. Flooded dock.
3. Helicopter deck.
4. Armed Commando helicopter.
5. Vehicle stowage deck.
6. Offset funnels.
7. Seacat guided missile system.
8. Infantry landing craft.
9. Command HQ and operations room.
10. Skynet Satellite Communications Aerial (now removed).
11. Radar and radio equipment.
12. Bridge structure.



Photos: courtesy Ministry of Defence. Drawings: C.D.I.



# Pie in the Sky

Flying Saucers are usually associated with science fiction, but the idea of a dish-shaped transporter is now being looked at in England. Known as the Skyship, this huge craft may be the aerial freightliner of the future!



**D**O YOU believe in flying saucers? If not, you may have to change your ideas before the end of the 1970s for designers are now seriously considering a saucer-shaped craft for cargo carrying—the Skyship.

Design of this odd aircraft is on a really big scale—700 feet in diameter and 208 feet deep at its centre, it will weigh 800 tons and be capable of lifting fuel and a payload of 400 tons.

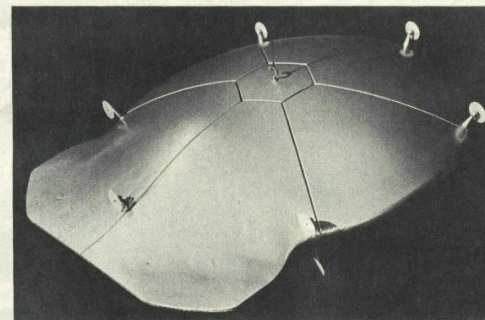
No fewer than ten Rolls-Royce Tyne turboprop engines mounted round the rim of Skyship will drive large propellers through shafts, the props being mounted on pylons similar to those used on the cross-channel SRN-4 Hovercraft. The pylons will be computer-controlled, swivelling to enable the craft to move in any direction.

## HELIUM GASBAGS

Skyship's lift will be provided by the gas helium contained in 19 gasbags throughout the ship. These will be grouped around a central "core" which will hold the cargo in containers. The gasbags will be inflated with helium at a cost of about £1.4 million when the ship is built, and under normal operating conditions this will remain in the gasbags throughout the ship's life, merely requiring topping-up from time to time.

No single gasbag contains more than 10 per cent of the total volume of helium—37 million cubic feet—therefore a major gasbag failure could not cause more than a 10 per cent loss of lift.

Helium has an additional big safety bonus: as an inert gas it can envelop a fire and extinguish it. All compartments of Skyship will have helium inlets which can be



opened in the event of fire to bring it under immediate control.

The designers have also allowed for that most frightening possibility, a mid-air collision with another aircraft. They say that even if Skyship were struck by a large airliner, it is unlikely that more than a third of the lift cells would be completely destroyed and it would therefore fall at a slow rate, minimising the ground impact. However, since Skyship will be operating below the commercial airways a more likely collision would be with a small aircraft which would cause comparatively little damage.

## LOW NOISE

Fuel fires can be hazardous in aircraft, but the danger will be greatly reduced in Skyship by keeping the engine fuel within the lift cells in an atmosphere of helium where a leakage could be smothered. As the engines are enclosed within the hull of the ship similar treatment can be applied to them—this also, of course, means a great reduction in outside noise.

Wind tunnel tests with models and other studies have been completed and the concept was proved to the satisfaction of the design team, but how will the system work in practice?

The ship would be operated from a number of bases set up near motorways in the countries

which it is intended to serve. A circular pad of about 10 acres would be sufficient, with anchorage points arranged around its perimeter. To load or unload cargo, Skyship would hover above the pad and lower hawsers from synchronised winches; the hawsers would be connected to anchorages by the ground crew. When connections had been made, Skyship's engines would be used to produce upward thrust, tensioning the anchoring cables and enabling the craft to be winched down on to the pad.

At this stage, a detachable auxiliary container carrying the cargo would be released, Skyship would be winched up again to clear the top of the container which would be moved away and replaced by a ready-filled fresh container. Skyship would then be winched down again and the connections made firm ready for take off.

When leaving its base, Skyship would rise to its operating altitude of between 5,000 and 7,000 feet, well below the normal airways for commercial airliners, and proceed to its destination at about 100mph. An ideal route length would be about 600 miles.

## ONE AN HOUR

Operating bases could be considered as inland ports, capable of dealing with one Skyship an hour;

in addition to the landing pad some 20 acres of land would be needed for administrative buildings, fuel storage and so on.

A main base for Skyship overhauls and crew training would be established when the size of the fleet justified it, and the designers say that many areas of East Anglia would be suitable for this purpose.

In an emergency Skyship would be able, like a conventional airship, to decrease its weight by dropping ballast, or decrease its lift by releasing gaseous fuel or helium into the atmosphere.

Skyship could also have military uses, although it would need to be kept well away from the front line as it would present a very large target! The type of operation foreseen could be rapid movement of troops and their equipment from Britain to the Continent. In a single operation one Skyship could move two complete infantry battalions consisting of 1,600 men, 70 small and 14 large vehicles, 60 trailers and 100 tons of stores. This load would require more than 100 conventional transport aircraft at present in service with the RAF.

## BIG PAYLOAD

For naval use, Skyship could operate over the sea at very low altitude, combining the ability of a warship with its own advantages, being much faster, cheaper to build and operate, and invulnerable to torpedoes. As an anti-submarine craft it is claimed that it would be able to do everything an aircraft could while having a much greater endurance and very large weapons payload.

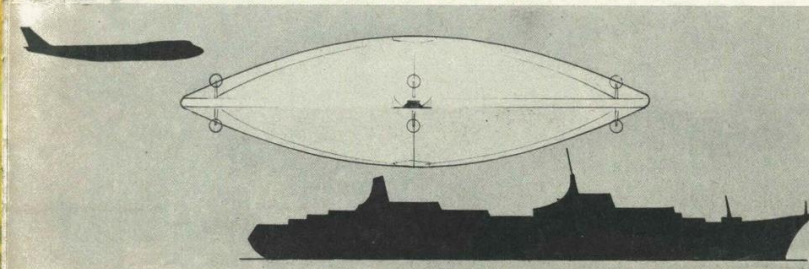
It could use detection techniques which at present are confined to surface units and, if nuclear power could be developed as a means of propulsion, Skyship would be able to match the nuclear submarine's endurance and keep it under constant surveillance.

This may all sound very much like a TV science fiction story but there are more advanced than you may realise. Backers can be found—and two companies, one in Europe and the other in America have shown interest—the project could go ahead. A cost of between £10 and £15 million per ship, including research and development costs, is foreseen—it may sound a lot but represents only about the present cost of a single Boeing 747 Jumbo jet.

The first step would be construction of a piloted scale model, a single-seater, to prove the idea in actual flight trials. If the go-ahead is given fairly soon you could see this at the 1976 Farnborough Air Show.

Success with these trials could bring the full-size Skyship to reality by the end of the 1970s. Now do you believe in flying saucers?

Above right: A wind tunnel scale model of Skyship which has already proved that the shape of the transporter works. Below: The size of Skyship is shown here in comparison with a Jumbo Jet and the liner Canberra.





The *Barbara*, fitted with three rotors, at the end of her voyage to New York.



## Rotor Power

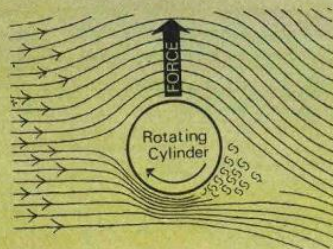
SOME SHIPS have been called freaks because of their shape or the peculiar tasks they are designed to carry out, but in a few cases it is the method used to propel the ship that has made it unusual.

It is interesting that a form of marine power first tried in the early 1920s, and later abandoned, had interest renewed in it again during the recent energy crisis as a possible fuel-less engine for the world's merchant fleets. This was the Flettner rotor, a peculiar form of wind power.

Free power from the wind had long been superseded by steam power and even the motor ship was in common use when German engineer Anton

**The *Buckau*, the first ship converted to Flettner rotor power, the principle of which is shown in the diagram. By creating a vacuum on one side of the spinning rotors, the ships moved forward in the direction of the arrow but at right-angles to the wind.**

Flettner invented his rotor ships. His ideas were based on the theories of Daniel Bernoulli, an 18th century Swiss mathematician who discovered that motive power could be obtained from a vacuum created by wind striking a spinning rotor. He found that this device moved forward but at right angles to the wind's direction because of the unequal air pressure created on one side of it.



The German shipping company of Hanseatische Motorschiffahrt A.G. owned a three-masted auxiliary schooner called the *Buckau* and, considering Flettner's rotor idea as a possible cheap alternative to motor or steam power, they decided to convert her. This took place in 1924, four years after her original completion by Fried Krupp of Kiel in 1920.

*Buckau* was no yacht. She was a general cargo ship of nearly 500 tons measuring 156ft. overall with a beam of 30ft. Her masts were removed and in their place were fitted two large tubular rotors each 50ft. high and 12ft. in diameter. These were spun by two electric motors powered by a single 45hp diesel driven generator.

Her revolutionary wind engine—for this is what the Flettner rotors were—was not her sole means of propulsion. The 300hp MAN diesel that had been used as the auxiliary in her days as a schooner was retained for manoeuvring in port and on occasions when the wind fell away.

The vessel took on a top-heavy appearance but it was found that the rotors created more power than conventional sails on top of which they were totally mechanical and required no crew to set, reef or furl them. Maintenance—other than for the rotor bearings and diesel generator—was also virtually nil for wear and tear was non-existent.

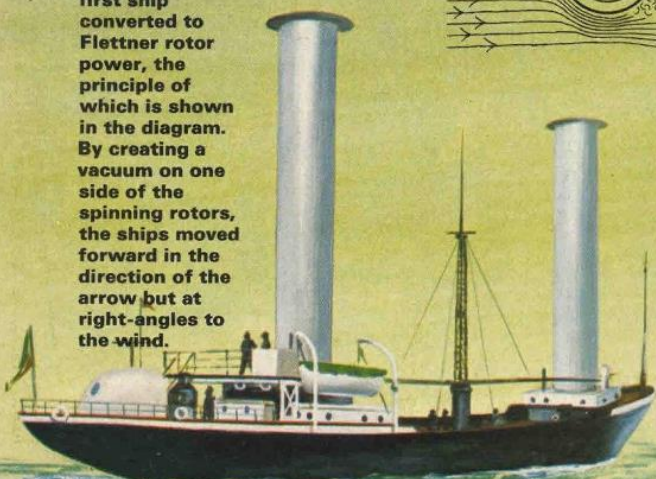
The *Buckau* eventually achieved a speed of eight knots in a good wind; a very competitive performance against steam driven cargo ships of the period. Her owners evidently con-

sidered the experiment had a promising future and two years later, in 1926, an even larger craft of 2,785 tons was built specifically for this form of power.

Called the *Barbara*, she was 293ft. overall and fitted with three rotors each 60ft. high and 14ft. in diameter. The *Barbara* could make 9.5 knots in a fair breeze; over half a knot greater than her speed under auxiliary motor power.

There is no record of whether the *Barbara* was ever used commercially, but she did make a trans-Atlantic crossing to New York under rotor power and was received with great enthusiasm by American marine engineers. Unfortunately the reason that the Flettner rotor was never developed was one that we would find strange in the light of the world's present energy crisis. Back in the 1920s and 30s the most plentiful fuels were coal and oil, not only plentiful but also cheap. This low price made research into bettering the system uneconomic even though the end result would have been virtually free power.

Both the *Buckau* and *Barbara* were therefore eventually converted to conventional powered screw-driven vessels and their rotors scrapped. Although they slipped away into marine history the present shortage and high cost of fuel oil have possibly set many ship designers thinking along those lines. Although their speed would be slow by today's standards, such a drawback would not necessarily be important with bulk cargos they could carry.





10p Weekly No. 29 October 4-11, 1974

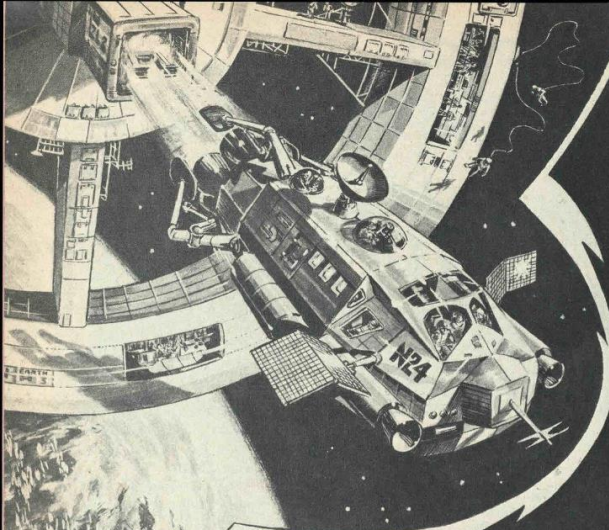
# Speed & Power



**200 MPH  
THUNDERBOATS  
LOVELY LAMBO  
RAF TO THE RESCUE  
\* \* \*  
PLANES CARS TRAINS  
SCIENCE FICTION  
SHIPS SPACE**







**M**OOONBASE . . . this is ferrycraft November Two Four. How do you read? Over.—November Two Four . . . Moonbase. Reading you loud and clear. Good morning. Earth monitoring confirmed. Go ahead.—Moonbase . . . Two Four. Good morning. This is a scheduled flight departed orbital station Kilo Kilo Bravo at 0842 Zulu on flight plan four-niner-zero-three. Echo tango one seven minutes. Estimating lunar orbit retrofire at echo tango seven niner hours.

The style of radio patter may be familiar, but are the implications just science fiction fancy? They are certainly not fact at the moment, but the fancy is already very much in the heads of scientists.

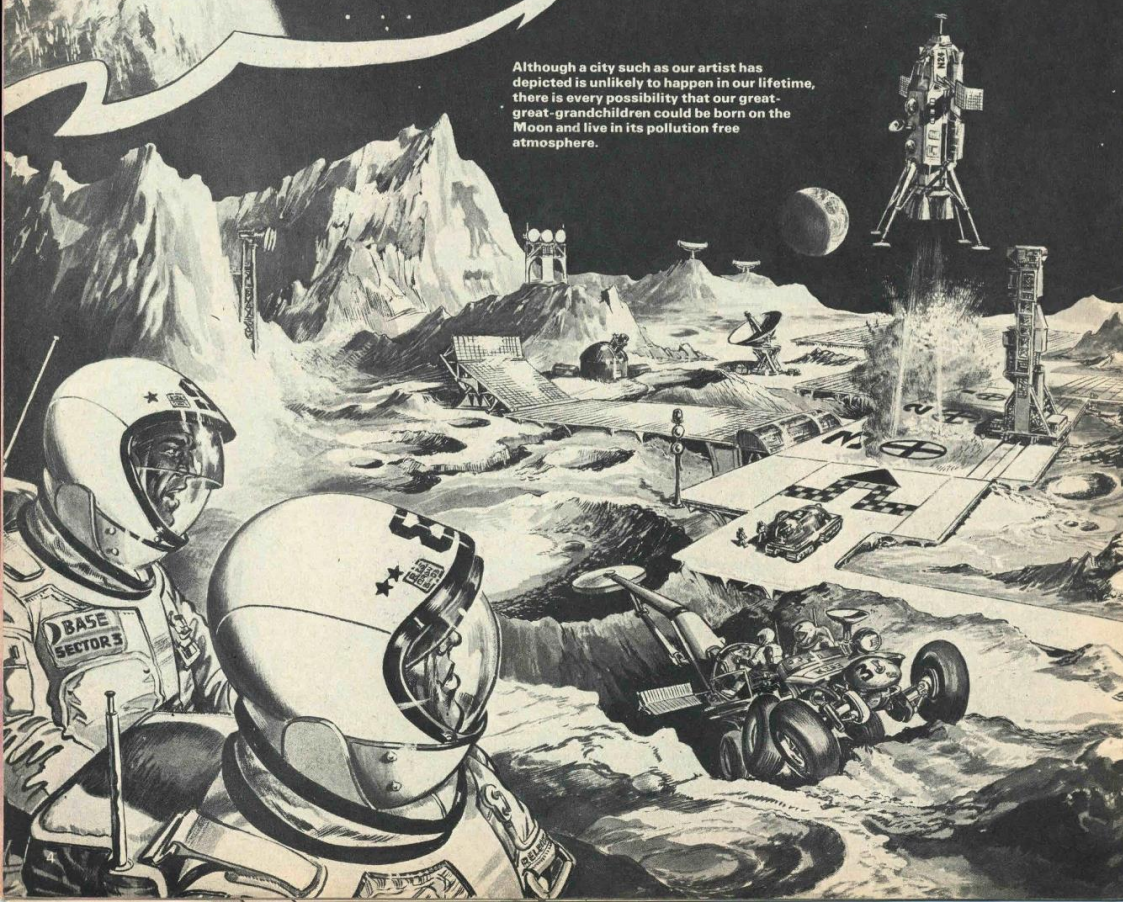
At some future date, the establishment of a permanent base on the Moon is almost inevitable. Quite when is really a matter of economics. Right now we cannot afford even to plan such an enterprise in any detail. Long before

that stage we must develop an efficient means of getting to the Moon.

In about seven years' time, America's new reusable space shuttle will start plying back and forth between Earth and low Earth orbit. Then may come the building of the first simple permanent space station in orbit. The mechanics of spaceflight dictate the use of excessively large vehicles if any sizeable payload is to be carried direct from the Earth's surface to the Moon (e.g. the Saturn V). The answer is to transfer the load in orbit to a pure space vehicle operating solely between the Moon and Earth orbit. And this is where the space station comes in.

No one can yet say for sure what course lunar colonisation will take. One thing is certain, however; the undertaking will be colossal. And, like any pioneering effort—such as that of the American West—it will have small beginnings and, if all proves well, unlimited deve-

Although a city such as our artist has depicted is unlikely to happen in our lifetime, there is every possibility that our great-great-grandchildren could be born on the Moon and live in its pollution free atmosphere.



# COLONISING THE MOON

**Man has already left his footprints on the barren soil of Earth's lonely satellite. No one can be certain when he will return, but a colony on the Moon will not remain just a dream for ever.**

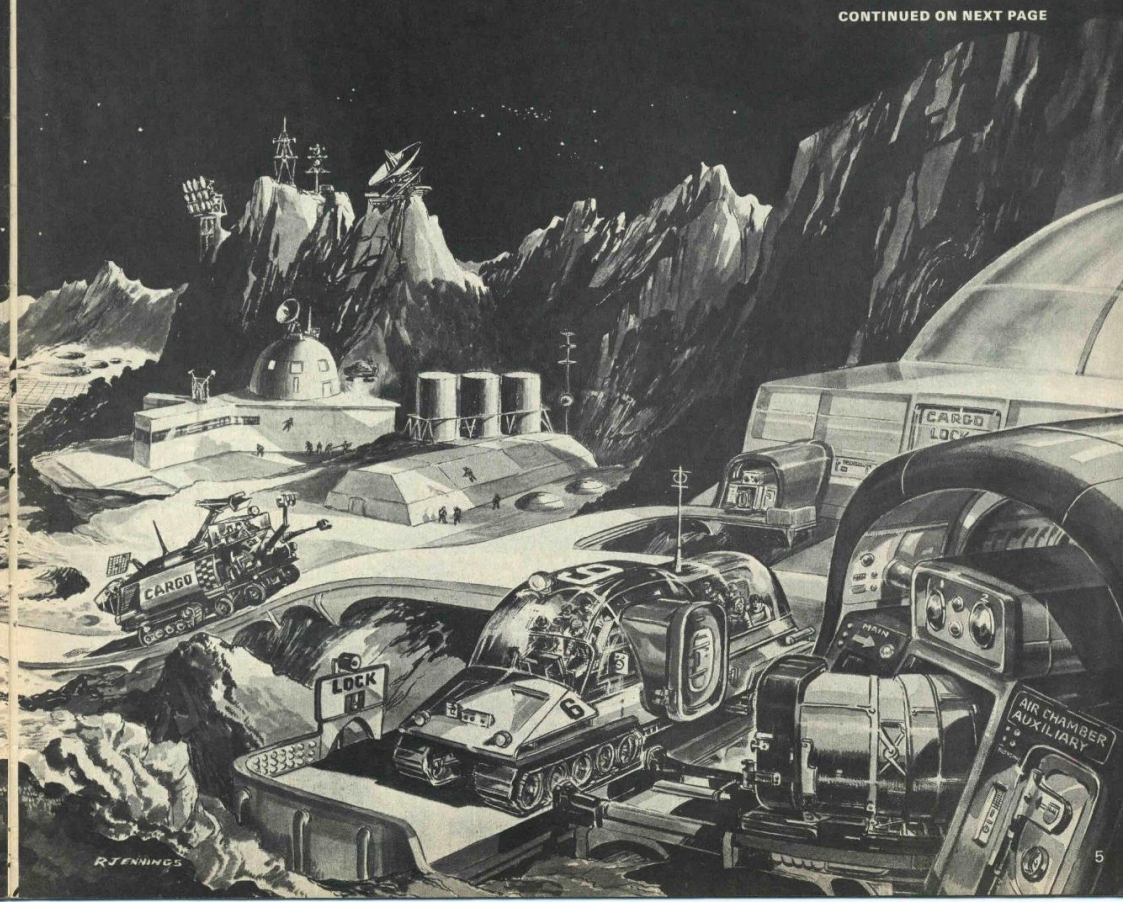
lopment in the future.

In the beginning will be the science and exploration station. It will probably comprise a very small group of pressurised dwellings, possibly inflatable, and a team of perhaps a dozen highly trained scientists equipped with simple vehicles such as cabin-equipped versions of the Apollo Lunar Rover. They will be left on the Moon for a few months. Their job will be to find evidence of oxygen, hydrogen or ice trapped in the rock below the surface. A permanent moonbase could not be economically supplied with all its air and water requirements from Earth and must therefore be totally self-supporting. Study of Apollo data has indicated the possible existence on the Moon of the chemical constituents of air and water. The future of lunar colonisation on a significant scale depends on the success of the pioneer scientists in finding these vital substances.

The next stage is the permanent base. This will be underground—initially just a cluster of cabins buried like present-day Arctic and Antarctic stations, and linked by tunnels. This is both to protect the occupants from the deadly solar radiation, a service provided for us on Earth by our atmosphere, and from the extreme temperatures of lunar night and day, as well as to assist airtightness within. A processing and recycling plant will extract air and water from lunar rock and purify it for reuse many times. On the surface above, a huge gleaming array of solar cells will convert solar energy into enough electricity to satisfy power needs. In effect, the base will operate like a large but stationary space ship.

Once fully established, Moonbase One will house perhaps a hundred scientists and technicians on tours lasting from six months to a year. Some will go out on surface exploration expeditions lasting

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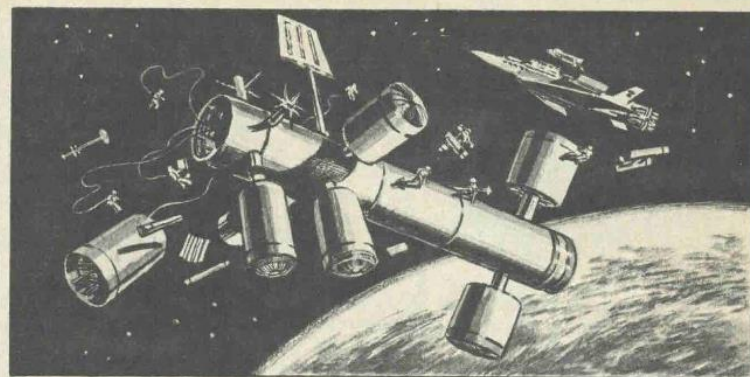


days or even weeks, probably travelling by a small, rocket-powered "helicopter" or fast, electric-powered surface vehicle, and living in inflatable huts. Others will build and operate a telescope to study the stars unobscured by any such barriers as the Earth's atmosphere. But most may well be involved in excavating the first real lunar colony.

What form such a colony will take is still very much a matter of guesswork. Almost certainly it will be underground. Equally certain is the fact that it will be big. There is no real likelihood of a mass emigration to the Moon. But the

colony will probably cater for holiday, residential and commercial interests as well as scientific. Eventually it will serve as a jumping off point for interplanetary travel.

It is to such a colony that November Two Four is headed. As it settles on to the landing pad you look out of the porthole on to a glistening plain of solar cells stretching as far as the eye can see. In the foreground are a couple more landing/launch pads with tall service derricks, and a dome-shaped control building, gilded to reflect heat, from which a caterpillar-tracked bus is emerging



The upper right picture shows astronauts assembling a space station while in orbit. Below it is an artist's impression of what the first simple colony on the Moon might look like. Years later, a complex city like the one below may become a reality.



to meet you. Behind the building tower a huge, dish-shaped radio telescope and the fat gun-barrel of an optical telescope.

As you step out of the lift, you find yourself at the edge of a vast cavern brightly lit from the roof perhaps 150ft overhead, so that the far wall is clearly visible half a mile away.

People skip lightly by your battery-powered taxi, their faces tanned by the synthetic radiation projected from the roof to stimulate growth in the oxygen-producing trees. Beyond the centre loom the administrative and research centres, reaching to the roof and linked to the surface laboratories above.

Suddenly you notice that the light is dimming to a low glow. Night time is being observed, both to save power and to maintain habitual day and night patterns. And then brightly lit cave mouths become apparent around the edge of the cavern. Entering one, you find yourself in a passage along a broad tunnel filled with vegetation. The farmyards of Moontown.

The crowds are collecting outside the two cinemas and the theatre in the square. Suddenly it all seems just a little like home. And that it is what it is supposed to do. Because, by this time, the occupants are whole families, not just those of technicians but of the first people who will deliberately choose to live in the quiet, comfortable, pollution-free world of the Moon.





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No. 30

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# Speed & Power

**Funnies  
are Fast**



**A New Life for  
HMS Belfast**

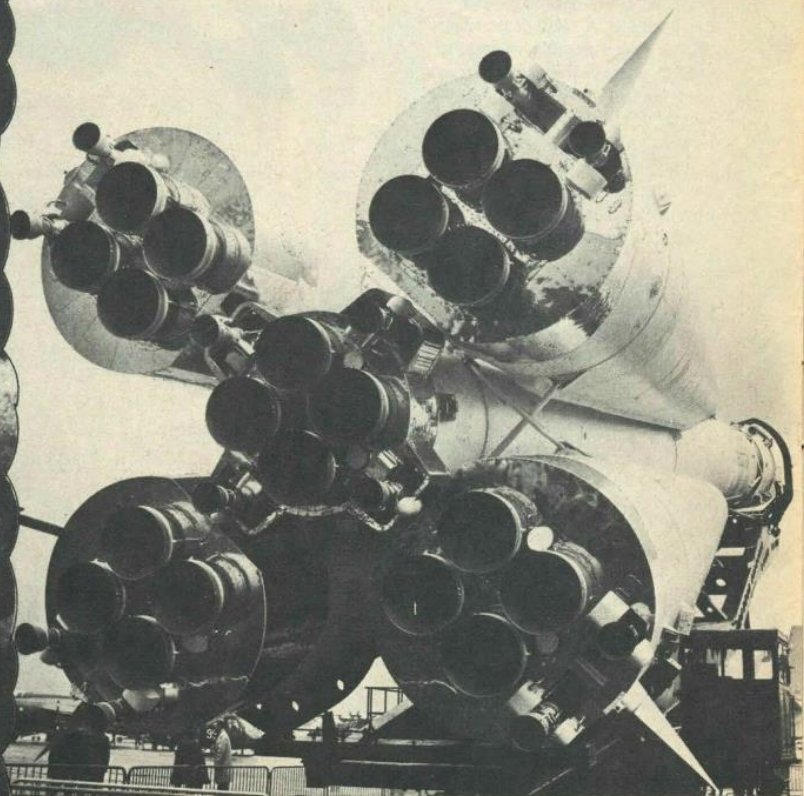
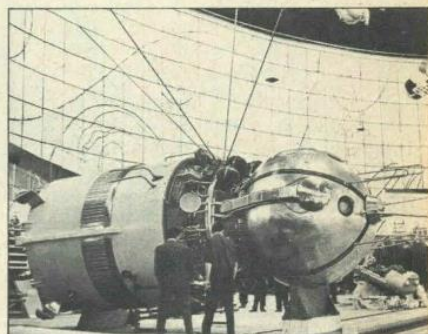


**Lightnings—  
Scramble!**



# Rocket ★ from Russia

Left: Towering into the sky like a huge monument, the three-stage Vostok carrier rocket. Right: A replica of the manned final stage of Vostok I, on display at an exhibition. Below: Worm's-eye view of the powerful Vostok engine, showing the 20 main thrust chambers and 12 directional thrust chambers. They burn up liquid oxygen and kerosene propellants at an amazing rate.





**W**HEN the first Soviet Sputnik began bleeping its way round its  $1\frac{1}{2}$  hour orbit of the Earth on October 4, 1957, not only the public but many important technical people were caught by surprise. When the weight of 184 pounds was announced—more than ten times that of the first planned US satellite—there were claims that the decimal point must have slipped, that it was too technically inferior to the US satellite for realistic comparison, even that it was all an elaborate hoax by the Russians. Nevertheless, it was there. Moreover, it was later revealed by the Russians, and confirmed by visual reports, that most of the launch vehicle was up there with it. So the total weight in orbit was 13,000 pounds!

That the rocket was big there was no doubt. The only real criticism, therefore, was the obvious inefficiency of its use for such a small payload. There was no subsidiary motor used to boost the Sputnik to orbital speed, so that the main rocket had to carry it all the way, which limited the weight of the payload.

And so began the great game of Soviet space analysis which has fascinated top western technicians ever since. For the Russians have never been very generous with information and the tiny trickle of facts usually released years after the event has done little more than confirm deductions made in the West. Of course, the US Defence Department, with its spy satellites and other information sources, knows far more than is generally available, and is even more secretive about its carefully gathered facts than the Russians themselves. But, in time, the picture of this first space launcher has become almost as full as that of any American rocket.

The rocket, which we in the West call the Standard or "A" vehicle, and which was later named Vostok after its first manned payloads, was much larger than the first American launchers. The same missile, with an assortment of upper stages, is still in use as a space launcher today.

The engines, which were to become those of the first spaceship, were developed under a crash programme between 1954 and 1957 in a race against US development of the Atlas missile. The work was performed by the Gas Dynamics Laboratory in Leningrad, home of Soviet rocket research since the 1920s. The engine is not as sophisticated as that of the Atlas. But, because of the Russian lag in miniaturisation at all levels of technology, the problems of power-to-weight ratio that had to be overcome made this design a fairly major achievement. The product is now

probably the most well proven and reliable rocket engine in the world.

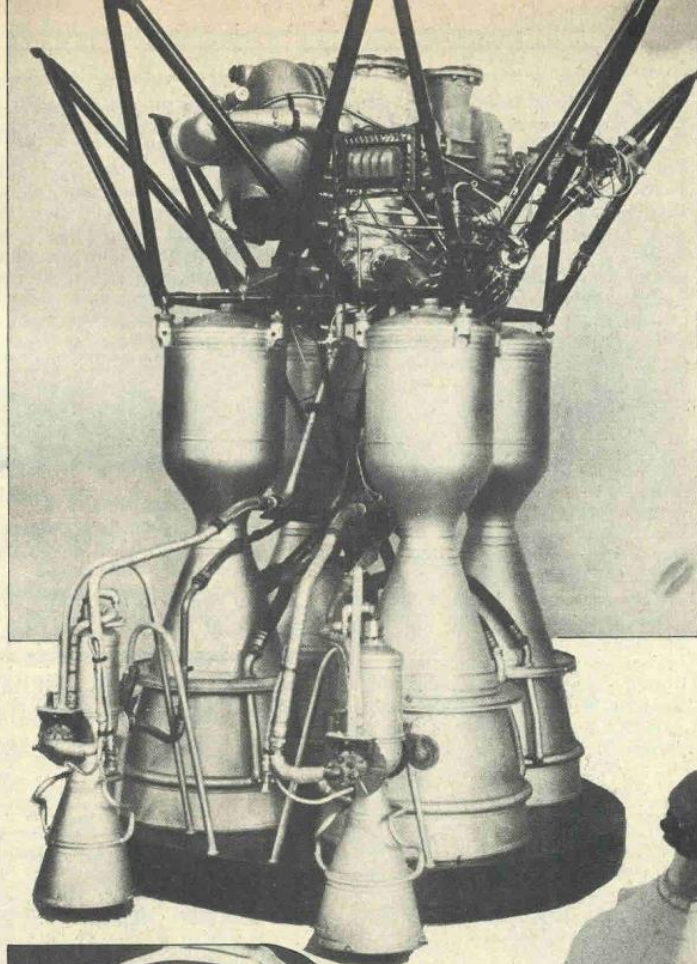
The engines were unusually powerful for the time, but their efficiency by today's standards was low. Undoubtedly those now in production have been modified and improved, but the total lift-off thrust of the cluster of 20 engines has remained virtually unchanged at 1.14 million pounds.

The design is complex. Without upper stages, the Russian "A" comprises a main core rocket, or sustainer as it is called, plus four huge strap-on boosters. The core is powered by four separate engines all receiving their propellants via a single turbopump, itself driven by an independent gas supply. The pump also feeds four small steering rockets, the whole being classified as a single engine named by the Russians as RD-108. In comparison, for example, the American Saturn V first stage has a separate pump for each of its five engines and each operates on fuel bled from the main supply.

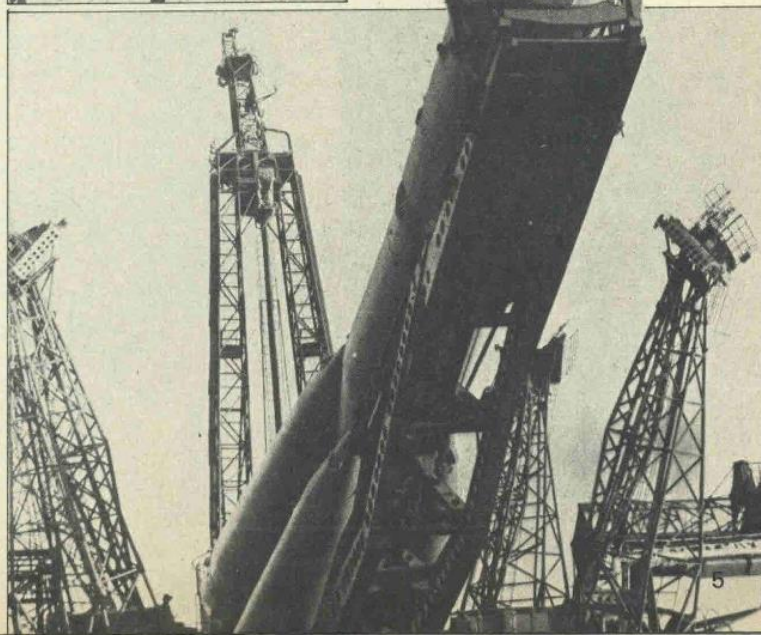
The four boosters are the same but each, with its own fuel tanks, is built in a long cone shape so that the top ends are smoothed into the core section to create a graceful streamlined effect. The core structure broadens above into a sort of hammerhead to provide extra tankage for its own engines. Compare this with the US Titan IIIC where the two solid-fuel strap-on boosters look like fully independent rockets, each with its own nosecone. The Vostok booster engines also differ from that in the cone in having only two steering rockets each. Because of this difference the engines are called RD-107.

So, in effect, there are 32 rocket nozzles, turning the worm's-eye view of the rocket into a fantastic pepper-pot nearly 39 feet in diameter. At lift-off all 32 of them spout flame generated by the kerosene fuel and liquid oxygen oxidiser burning at 60 atmospheres pressure with a specific impulse of 314 seconds. The boosters burn out first and are discarded at altitude while the sustainer drives the payload on with a (now) vacuum thrust of 225,000lb. Then, depending on whether the payload is an unmanned probe destined for the Moon or planets, or a three-man Soyuz spaceship on an Earth-orbit mission, the appropriate upper stages take over.

The nearest US equivalent is the Saturn IB, with a payload capability more than double that of the largest "A" type, the Soyuz launcher. But it must be remembered that the Russian "A", the world's first space launcher, has also been used successfully in its various forms more than 400 times so far. That is as much as the two US top scorers put together.



Photos: Flight International; Novosti.



**Top: With a thrust of 102 tons, this RD-107 engine helps power the first stage of Vostok. Centre: A friendly smile from Vostok 4 cosmonaut, Lt.Col. Popovich. Bottom: The Soyuz 9 spacecraft, with a Vostok launch vehicle, being prepared for lift-off.**



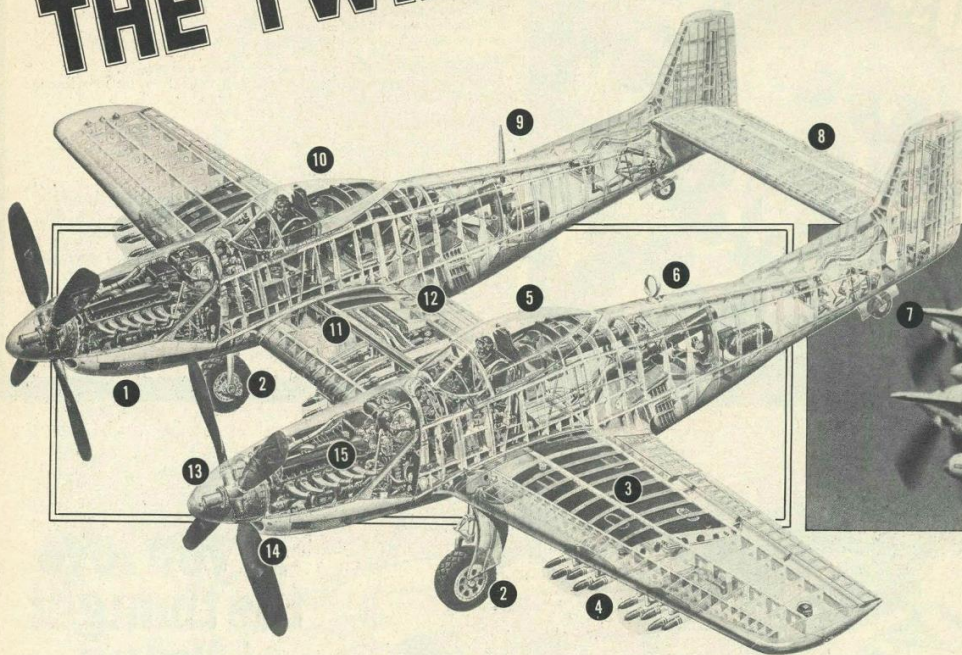


# MIGHTY MUSTANG

part 2

Flicking the gun switch to "FIRE", Lt. Hudson presses the red button. A Yak fighter falls in flames and the F-82 Twin Mustang has made its first kill ...

## THE 'TWINS' GO TO WAR



1. 1,860hp Rolls-Royce Packard Merlin engine. 2. Inward retracting main undercarriage leg.
3. Wing fuel cells. 4. Wing racks of high velocity rockets. 5. Pilot's cockpit. 6. Direction-finding loop aerial. 7. Retractable tailwheel. 8. Horizontal tailplane. 9. Radio aerial mast. 10. Radar operator/second pilot's cockpit. 11. Six-gun wing tray. 12. Ammunition bay. 13. Aero products propeller. 14. Nose air scoop. 15. Exhaust stacks.

With the end of World War II in sight, North American engineers looked at development of the Mustang into the post war years. The great range of the fighter had been proved in Europe and the Pacific and it was reckoned that if one P-51 was good, two joined together would be even better! This thinking was to lead to the unique F-82 Twin Mustang night fighter.

Meanwhile, improved versions of the standard Mustang were developed. Very similar to the

P-51D was the wartime P-51K, which had a different aircrew and detail changes, but the most drastic alterations to the basic design were made in the P-51H or lightweight Mustang.

When a fighter first flies, it is usually "clean", uncluttered by bombs, guns or drop tanks, but in combat, it may be called upon to carry all these items, as well as cameras and other heavy equipment. So, the weight rises and the speed, range and ability to climb are cut down.

These problems were in the minds of the Mustang's designers as they worked to clean up the aircraft and boost performance. After a number of experimental models had flown, the main production version, the P-51H, appeared in 1945. Although very like the P-51D, it was really a new aircraft, there being so many major changes.

The cockpit was raised to give better visibility over the nose, more fuel was carried in the fuselage, a new engine was fitted,

along with a taller fin, and a new stalky undercarriage. The whole airframe was re-stressed and the P-51H's typical performance was 487mph at 25,000ft. as against 437mph for the P-51D.

The P-51H was too late to see action in World War II, but the 555 built saw useful service in the USAF and Air National Guard, America's auxiliary air force. The final model of the Mustang, apart from the modern re-engined types, was the P-51L, a more powerful P-51H.

The first of two prototype P-82 Twin Mustangs flew for the first time on April 15, 1945, powered by two Packard Merlin engines, the third prototype being fitted with Allison powerplants. Basic-

ally, the P-82 was two lengthened P-51H fuselages joined by a centre wing panel and tailplane. It could be flown from either cockpit, although only one had full flying instruments.

In early P-82s, the wing had a pick-up point for an eight gun pod, but this was later used to take the massive radar gear of the F-82G night fighter, with six 0.5in. machine guns in the centre wing panel.

The incredible range of the P-82 was demonstrated in 1947 when an aircraft named "Betty Joe" flew the 5,051 miles from Honolulu to New York at an average speed of 334mph in 14 hours, 33 minutes.

When the United States Air Force was formed in 1948, all "P

for Pursuit" letters for fighter aircraft were changed to "F for Fighter", so by the time of the Korean War in 1950, the Twin Mustang was known as the F-82.

Flying from bases in Japan to cover the evacuation of American personnel after North Korea invaded the South in June 1950, Twin Mustangs scored the first air-to-air kill of the war. On the afternoon of 27 June, two days after the invasion, a flight of black-painted Twin Mustangs from the 68th (All Weather) Fighter Squadron sighted a group of Russian-built Yaks of the North Korean Air Force.

Within minutes, three of the Yaks were falling in flames, the first having been shot down by 1st

Lt. William G. Hudson, who is credited with the victory—the start of a long and bloody air war.

Its excellent range and ground attack ability meant that the Twin Mustang was pressed into service as both a day and night fighter in Korea, flying with Shooting Stars, Invaders, Thunderjets and Meteors in support of the United Nations offensive to push the North Korean army back.

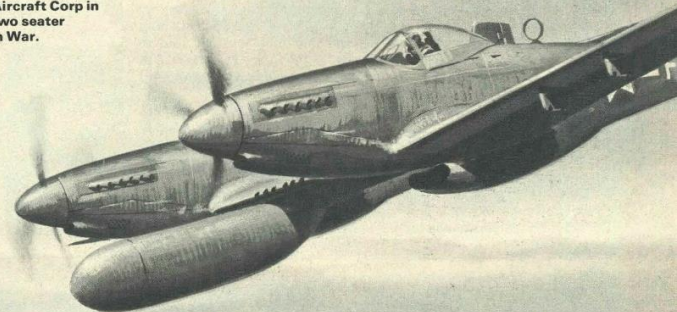
Such was the rundown of the world's air forces between 1945 and 1950, that even F-51Ds were used in Korea, flying with the US, Australian, South African and South Korean Air Force squadrons in both fighter-bomber and

CONTINUED ON NEXT PAGE

Below: Two of the new Mustangs rebuilt by Cavalier Aircraft Corp in 1967. The nearest one is a single seater, that behind a two seater with a longer canopy. Right: The first kill of the Korean War.



Photos: Roger Warren, Cavalier Aircraft Corp





reconnaissance roles until replaced by jets.

Both Twin Mustangs and F-51s had phased out of front line USAF service by the end of the Korean War, most of the "Twins" being scrapped, although the F-51 D still had a good military re-sale value outside the US and many were bought to be used as air racers.

But the Mustang was to have one more phase of military development. In 1967, the Cavalier Aircraft Corporation of Florida acquired the design rights of the original Mustang. Cavalier had the idea to strengthen the F-51 airframe to enable it to carry a wide range of modern weapons in the COIN—COunter INsurgency—role.

At that time, reports from the Vietnam War zone showed that, on certain missions, jets such as the Phantom and Thunderchief were too fast—and expensive—to be sent against light ground targets and that a slower, propeller-driven aircraft could do the job better. If it could be made to carry a good weapons load, such a machine as the Mustang would be much cheaper to build and operate and could make a slower, more accurate run-in to a target.

So Cavalier strengthened the

wings of the old Mustang, fitted bombs and rocket attachment points under the wings, gave it a taller fin and added a second cockpit for an observer.

In the event, no Cavalier Mustangs were used by the USAF in Vietnam, but a number were sold to South American air forces.

Along with a "new" military Mustang, Cavalier built a civil version, the Cavalier 2000. This one has a luxury interior and sound proofing and where the gun ammunition once went, the businessman can put his suitcase.

But the most drastic change to the Mustang's outline came when Cavalier fitted a long, slim Rolls-Royce Dart turbo-prop in place of the Merlin engine.

This aircraft, known as the Turbo Mustang, has come a very long way from the 1940 Mustang design and may well be sold to South American air forces to extend the type's life well into the 1980s.

So, North America's famous Mustang will be around for some time to come. Even if the military versions are phased out, those souped-up Mustangs that thrill the air race crowds at Reno will be in the air for a while. We'll be looking at racing Mustangs next week.



Above: One of the last flying P-51s left, this cream and gold fighter is often seen at US air shows. Below: On its way from Langley Air Base to California is one of the Cavalier Turbo Mustangs.



## Only 14, but he's a crack-shot already in the ATC.



When David joined he'd never held a rifle in his life. Now he out-shoots everyone, including his instructors.

Maybe you're a crack-shot with a .303, or could be you're better at something else.

Your local ATC squadron is certainly the place to find out. Because there are so many exciting activities you can do.

Besides flying and shooting, there's sailing, skiing, aqua-diving, radio, electronics and even parachuting.

One could be your speciality. But you'll never find out till you try.

Applicants for all ATC squadrons must be between 13-17 and resident in the U.K.



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H.Q. Air Cadets, RAF Brampton,  
Huntingdon PE18 8QL

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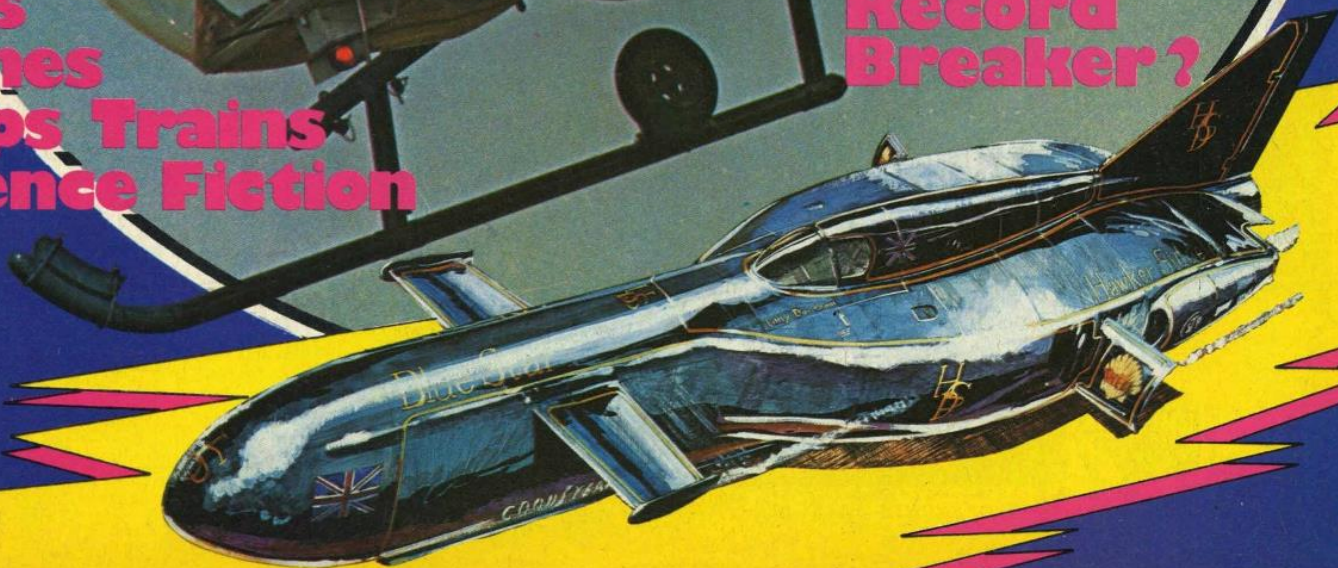
10p Weekly No. 31 October 18-25, 1974

# Speed & Power

**Fly Blue Eagles  
with Speed and Power**

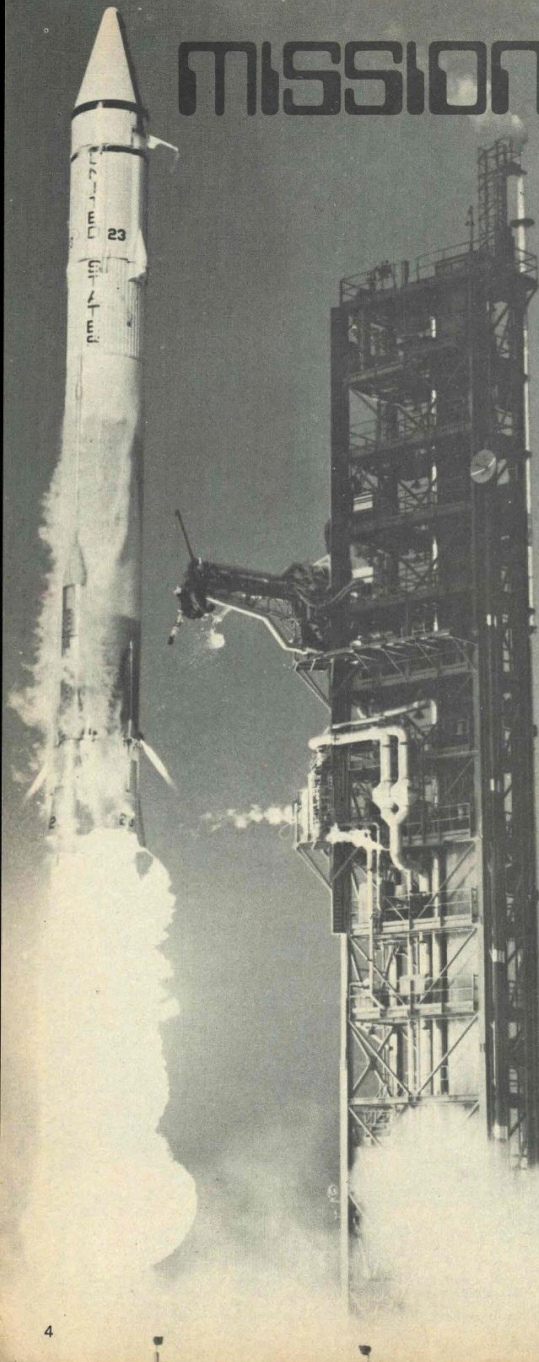
**Cars  
Planes  
Ships Trains  
Science Fiction**

**Britain's  
Record  
Breaker?**





# MISSION TO MERCURY



**J**UST LIKE piecing together a jig-saw puzzle, space scientists and astronomers are spending a lot of time trying to fit the known facts about the solar system into an understandable pattern. Their jig-saw is a puzzle on a gigantic scale. Some of the pieces are centuries old. Others are made up of information unearthed during the past few months. Perhaps the puzzle will never be completed, because there will always be some new discovery to add. But, as with an ordinary jig-saw, it's quite possible that the pattern will be recognisable long before the last pieces are in place.

One recent and important addition

to our store of knowledge about the solar system concerns Mercury, the smallest planet in the solar system and the Sun's nearest neighbour.

Mercury was known to the astronomers of the ancient world, long before the outer planets had been discovered. Until this year, however, not much more than its existence could be taken for granted. It is very difficult to see, mainly because of the glare of the Sun. Good sightings are seldom obtained by amateurs, and even professional astronomers using very powerful telescopes see only a rather hazy sphere.

For the revelation of Mercury in clear focus we have once again to

thank the modern wonder of space technology, together with the scientists and engineers who use it so skillfully.

The cratered landscapes shown here may remind you of the Moon, but they are all of Mercury, and were transmitted automatically over millions of miles of space from a small, unmanned spacecraft after a 160-day journey from Earth. Until they were picked up by America's Deep Space Network, in the form of electronic signals, no one really knew what the surface of Mercury looked like.

The pictures were taken by a remarkable little spacecraft called Mariner 10, which passed within 430 miles of Mercury last March and then, after going into orbit round the Sun, was programmed

from Earth so that it returned for a second look at the planet in September.

Mariner 10 was launched from Cape Canaveral in November 1973 on a fly-by voyage to both Venus and Mercury. It was the first spacecraft ever to attempt to survey two planets in a single mission, and the first to use one planet as a gravitational springboard from which to reach the other. No easy task, as you can imagine. If the craft had been only a mile off course when it encountered Venus, its margin of error would have jumped to 1,000 miles by the time it reached Mercury.

In fact all went well. Mariner 10 sped past Venus as planned, some 3,600 miles above the dense

clouds that obscure the surface. The pictures it took at this stage of the mission provided the first evidence that there are several layers of clouds covering Venus.

## DESOLATE SURFACE

A month later, Mariner 10 was flying past Mercury, and this time it was able to pick out clear details of the surface. It was no surprise to astronomers that the pictures revealed a desolate, Moon-like surface. Mercury was known to be extremely hot, and there was general agreement that its surface would appear to be bare and lifeless. What was remarkable was the clarity of the pictures. Mission scientists said they were "spec-

tacular" and "beyond our wildest imagination".

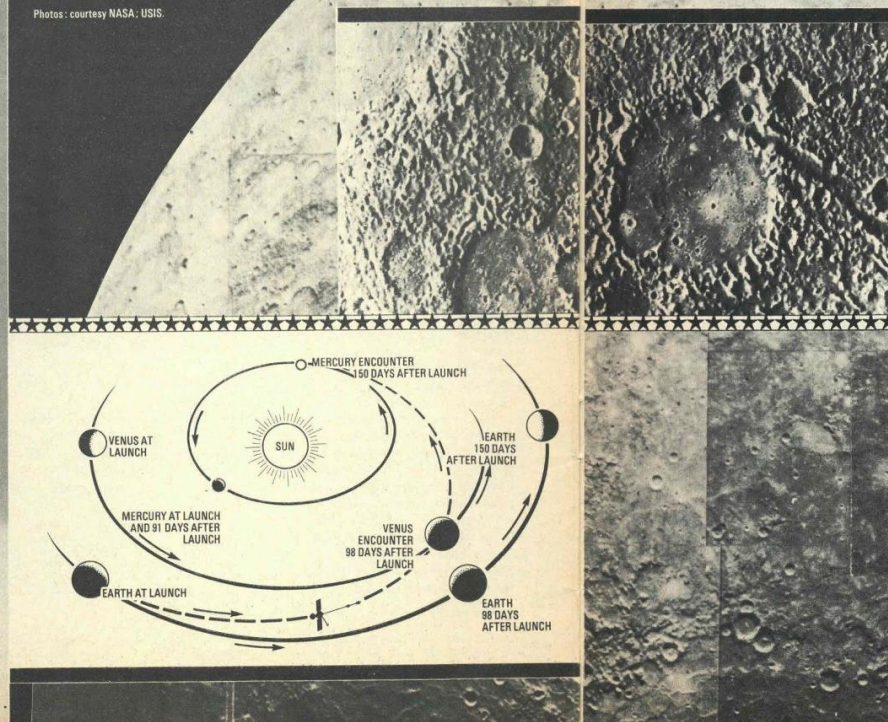
Other surprises were provided by Mariner 10's instruments, which revealed something not hitherto suspected—that Mercury has a magnetic field stronger than that of Mars or Venus. This suggests that though the surface resembles the Moon, the interior of the planet is like the Earth's heavy iron core. Another instrument aboard the craft showed that Mercury is surrounded by a thin atmosphere composed mainly of rare gases—neon, argon and helium. Other known planetary atmospheres are composed largely of hydrogen and helium.

Mariner 10 showed that the temperature on Mercury varies tremendously. At high noon it is the hottest of the nine planets, with temperatures up to 450 degrees Centigrade. At night it can drop to 280 below zero.

Though Mercury's dry and desolate surface has a Moon-like appearance, there are no visible mountains, plains or valleys similar to those on the Moon. Some of

**Left:** With a spectacular display of power, the satellite, on an Atlas-Centaur rocket, blasts off. Its destination is Mars. **Bottom:** The route of Mariner 10 on its flight to Venus and Mercury. **Right:** Close-up of Mercury, taken by Mariner 10 from an altitude of over 21,000 miles. **The large crater is about 50 miles in diameter.** **Far right:** Pieced together out of 18 separate Mariner photographs, this picture shows a large area of Mercury and its moon-like appearance.

Photos: courtesy NASA; USIS.



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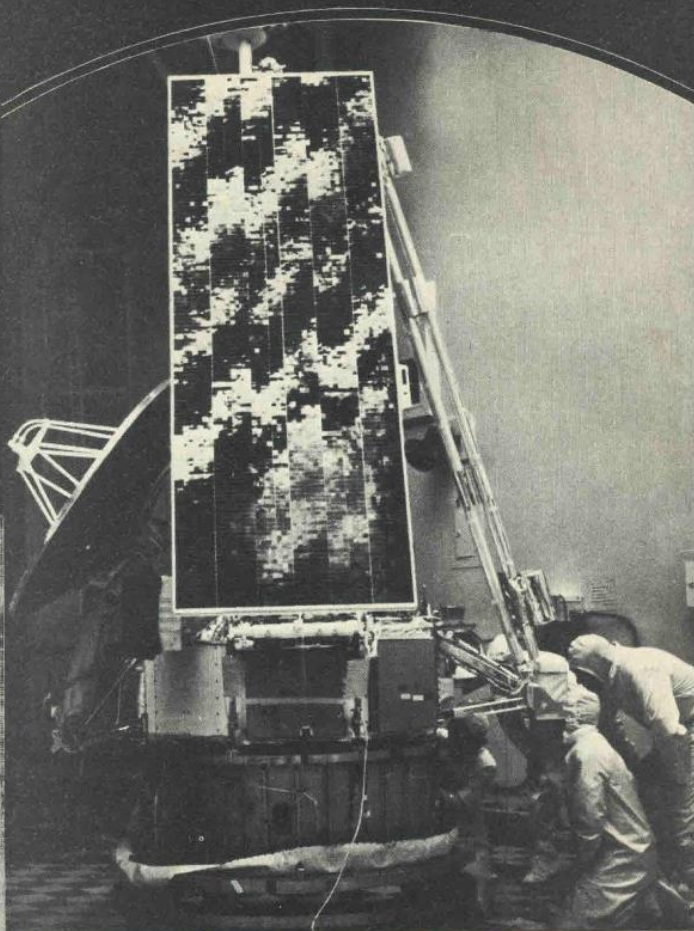
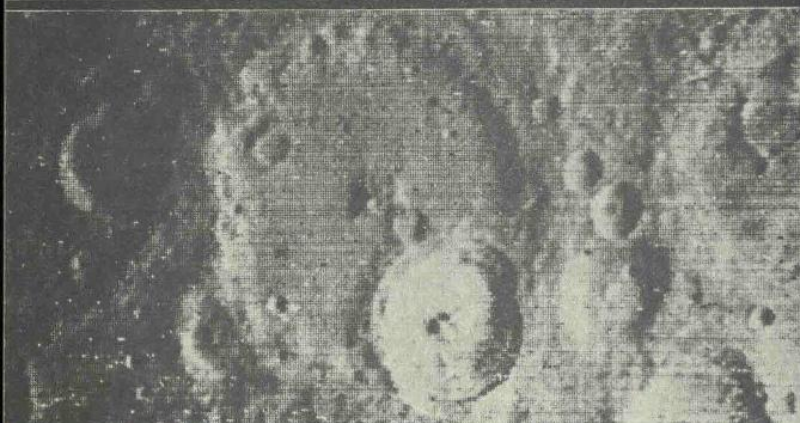
the craters are quite large, however — up to 70 miles across.

There was a flurry of excitement at one stage of the fly-by, when mission scientists thought they had discovered an unknown moon circling Mercury. The mistake occurred when an on-board ultraviolet spectrometer, searching for evidence of an atmosphere on the planet, detected a source of reflected light. This phantom object seemed to be moving. So the scientists, suspecting the presence of a moon, made a searching examination of every available photograph for further evidence.

They were to be disappointed, however. The search revealed

nothing, and it was eventually discovered that the light was radiation from a distant star. An understandable error, in the circumstances; and in admitting it the Mercury team noted, somewhat ruefully that it had been made on April Fools Day!

**Below: The uninviting surface of Mercury, photographed by Mariner 10 (shown right). In the picture Mariner is being prepared for launching. It carries two TV cameras and six scientific experiments, and was the first craft to explore Mercury, the smallest planet in the Solar System.**



## If you're too young for a motorbike, try one of these.

Every member of the ATC has a chance to fly. Even if he's too young for a motorbike!

So if you like aircraft, if you like adventure, the ATC has a lot for you.

As well as flying, there is now the opportunity to take part in parachute jumping, sailing, water-skiing, aqua-diving, mountain climbing, shooting and camping both at home and abroad.

So if you're between 13-17 and would like a little more adventure in your spare time, fill in the coupon and we'll send you the details.

Applicants for all ATC squadrons must be between 13-17 and resident in the U.K.



# ATC

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H.Q. Air Cadets, RAF Brampton,  
Huntingdon PE18 8QL

Name \_\_\_\_\_

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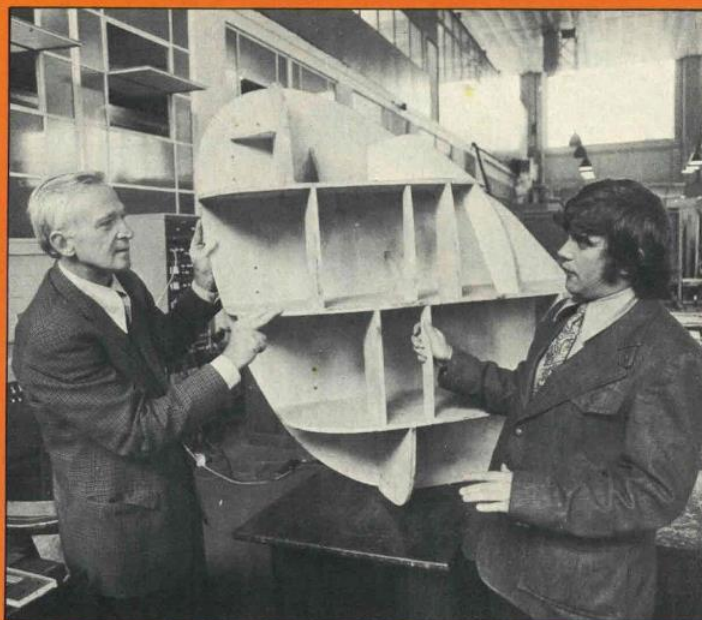


# TOMORROW'S RECORD-BREAKER!

Besides brave drivers and supercharged cars, the story of the Land Speed Record is about the problems of finding financial backing. Now there is an exciting British design which could smash the record with fantastic missile-power—and £250,000!

Right: A wooden mock-up of the safety capsule that will enclose *Blue Star's* pilot, Tony Densham. The finished capsule will probably be made of titanium.

The present world speed record is 635mph, held by American Gary Gabelich. But this is for a rocket-driven car. The current record for a wheel-driven car is 409mph, held by another American Bob Summers. The new wheel-driven *Blue Star*, a British car, is expected to approach 600mph.



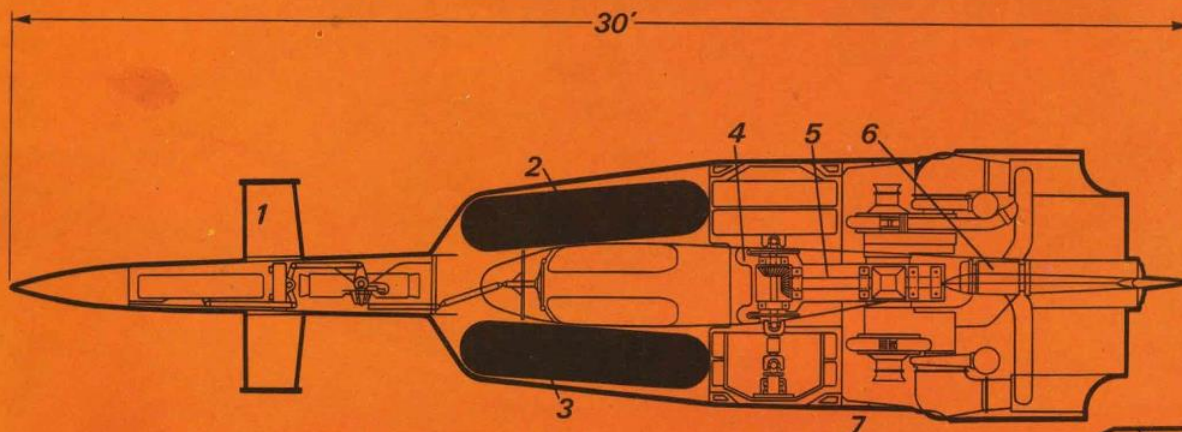
**F**UEL ON. LOX ON. IGNITION. FIRE! Tony Densham has a split second of tension-gripped expectation, then 6,400hp of rocket turbine is unleashed behind him.

Only 20 seconds later his speed is a staggering 550mph as he charges along the immaculately smooth dried out salt lake at Bonneville salt flats, Utah, USA.

But there is no time for Tony to feel satisfied with having just smashed the world wheel-driven land speed record for Britain, because it's time to stop! Out come the air brakes, out pops the tail parachute, and on go the wheel brakes.

As he comes to a halt Tony can reflect on the fact that he has just accelerated from zero to nearly 600mph and back to zero again in just 6½ miles. He has been alternately slammed into his seat by the acceleration, bounced about during the run (at that sort of speed even the smoothest of lake beds feels like cobblestones) and thrown into his harness as he "stood on the anchors".

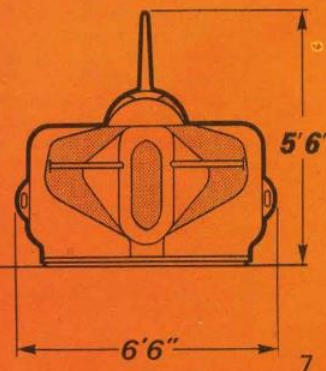
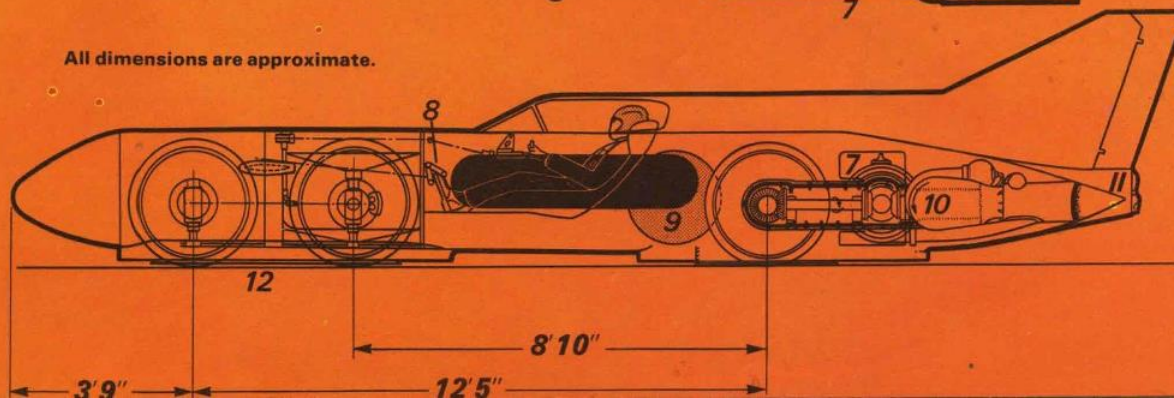
All this may be but a gleam in the eye of a bunch of enthusiastic spacecraft designers at the Steven-



## KEY

1. Canard foreplanes.
2. Starboard kero tank.
3. Port kero tank.
4. Inboard disc brakes.
5. Drive chain.
6. Supercharger.
7. Air brake.
8. Canard incidence control.
9. Liquid oxygen (LOX) tank.
10. Turbine.
11. Chute stowage.
12. Negative ground effect skirt.

All dimensions are approximate.





age, Harts, development centre of Hawker Siddeley Dynamics but it could very easily happen. Working in their spare time, the team members led by Dave Gosling, one of the senior engineers at HSD, have done a complete computer-aided project study for the vehicle (to be called *Blue Star*) with the aid of their own vast experience of building satellites and rockets. Also working on the project are a group from the country's top technology college—the Cranfield Institute of Technology in Bedfordshire.

When the team get around to

actually building the device during the next couple of years they will draw on the Cranfield student population to give them a hand.

The biggest stumbling block at present is money, and the team are looking for about £250,000 in sponsorship from companies who could stick the names of their products on the car.

Flying "on the deck" is a phrase familiar to most pilots, though rules and regulations and common sense prevent them from doing it. But even for those military pilots who do such low flying it means going down only to 50 or 100 feet.

For supercars like *Blue Star* "on the deck" means just what it says.

It's a blend of car and space rocket so it's not surprising that going at the speed it will *Blue Star* will want to take off. So it will have little canard wings at the front to push the nose DOWN and it will even have a *reverse hovercraft* system to actually suck it to the ground as it zooms along at speeds quite close to that of sound.

The record breaking rules say that the car must have four wheels but they don't say that they have to be arranged like an ordinary car. So *Blue Star* will have the front

two one behind the other to make the car effectively into a tricycle and so reduce its width and drag.

The front wheels will steer but only a tiny fraction because the car won't have to turn corners, only keep a straight course. It would be disastrous if it went into a front wheel skid of any sort because the tyres would very quickly melt with the friction, so *Blue Star* will have a plane-type rudder to do most of the steering work and allow the front wheels to remain pointing straight ahead.

The car itself will be built as a "space frame" in aluminium, which

means that it will have a frame, rather like that of a bicycle, which which will be faired in with aluminium panels which do not themselves carry any loads.

But the engines are the most interesting part of the car because they were never intended as engines at all, but as fuel pumps for the *Blue Streak* missile!

In a big rocket the amounts of fuel consumed per second is massive, so the pumps have to be big and powerful to be able to push the fuel—in this case kero-



Above: One of the turbo-pumps from the old *Blue Streak* that will be used in *Blue Star*. Right: An artist's impression of *Blue Star* being prepared for a record-breaking attempt. The car should accelerate from 0 to 600mph in just 30 seconds!

sene (paraffin)—into the combustion chamber against the back pressure of the rocket firing in the chamber. The only way of providing enough power to drive the pump is to "tap off" some of the rocket exhaust itself and pass it through a turbine. The turbine is fixed to the same shaft as the fuel pump and so drives it round.

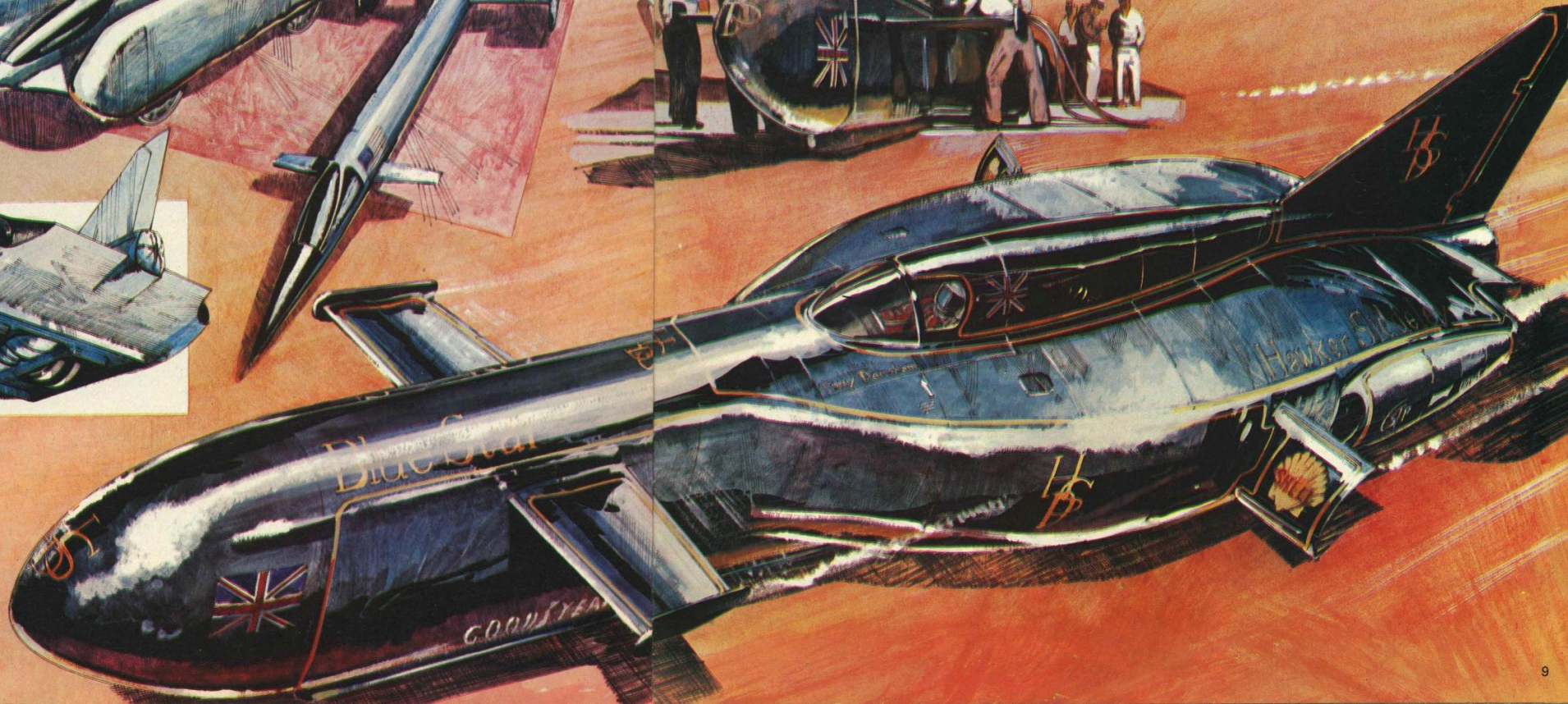
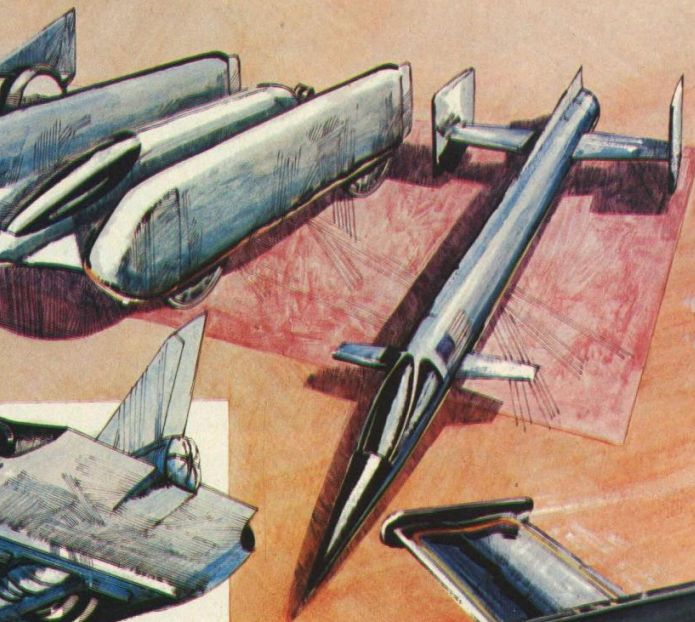
What the *Blue Star* team are doing is to forget about pumping fuel with the pump (which is mounted on a shaft) and to fix a gear wheel on to that shaft. Through a more or less conventional car-type transmission, the power put into that shaft by the turbine will be used to drive the vehicle along. In fact, *Blue Star* will use two such ex-*Blue Streak* missile fuel pumps to drive it along at near-sonic speed.

If it comes off, that will be the fastest any wheel-driven car has ever travelled—and a fantastic achievement for Britain.

Above, on left: The Dixon "Dart", a car that was planned to be very light and small. Tapering from cockpit to



finned tail, it's easy to see how it got its name. But the "Dart" was a non-starter. The Schmid-Orpheus (centre) was a German car planned in the 1950's, but never built. It is still waiting for a sponsor. Spirit of America—Sonic II (shown top right) has only reached the model stage. If built, it will have a thrust of 35,000lbs, with a special cockpit capsule that can be ejected in an emergency. Right: A car that could really be going places—fast! The British *Blue Star*, awaiting backing. It is planned to reach speeds of nearly 600mph to smash the world record. Inset (above) shows *Blue Star*'s wheel arrangement.







THE LITTLE engine bursts into life with the sound of a swarm of angry wasps and the little radio-controlled aircraft gracefully takes to the air. There is little to distinguish the model aircraft from any other—except that this is no plaything and it can carry bombs...!

Many enthusiasts have long taken pleasure in "piloting" radio-

The little *Mossette* has a different task. With a shape not unlike that of several wire-guided anti-tank missiles, it has been produced to give realistic training to missile operators. A little 6cc engine drives the *Mossette* at speeds up to 207mph, and a smokeless flare enables the operator to align the mini-missile-trainer with the target. A net is

# MODEL PLANES FOR THE ARMY

But they are not for fun

The army commander can hardly believe his eyes—aircraft! His radar saw nothing but they're right overhead. He hears a loud buzzing and checks again. Model aircraft? Impossible! But what's that falling... Seconds later he watches in horror as his petrol dump goes up in a giant mushroom of flame...

controlled aircraft and every now and then championships are held to determine which pilot can get the most from his little craft. The ability of radio-controlled models to do almost anything that a real aeroplane can do gave experts at the Royal Military College an idea, and their work has resulted in a whole range of miniature aircraft now being built by the Aero Electronics (AEL) company. Model aircraft have joined the Army!

AEL produce a variety of RPVs (remotely piloted vehicles) which can do a great deal more than the enthusiast's week-end pride and joy! The *Heron*, for example, is the most conventional design in the AEL range. It is also the largest with a wing span of 9ft. 10in. Its 56cc engine is fed from the half-gallon tank, allowing a thirty-minute flight time. Designed mainly as a target tug, the *Heron* tows a ten foot drogue and can achieve a maximum speed of 120mph!

stretched out in front of the target to reduce damage but the nose cone has been designed to be expendable—a new one can easily be fitted so that the *Mossette* can be used again.

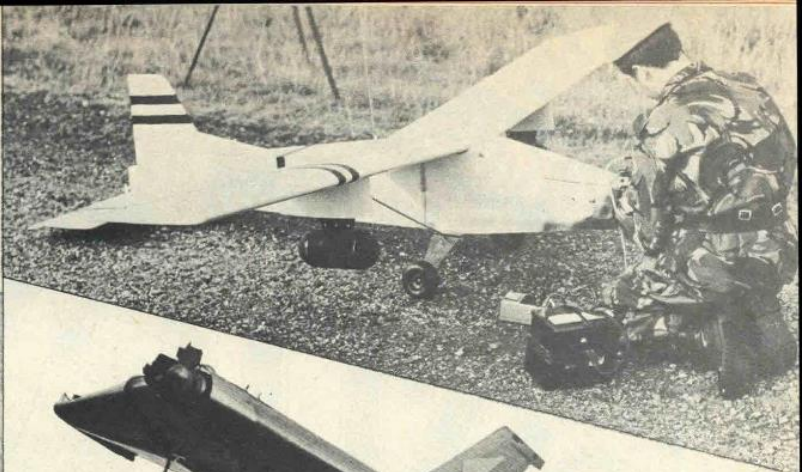
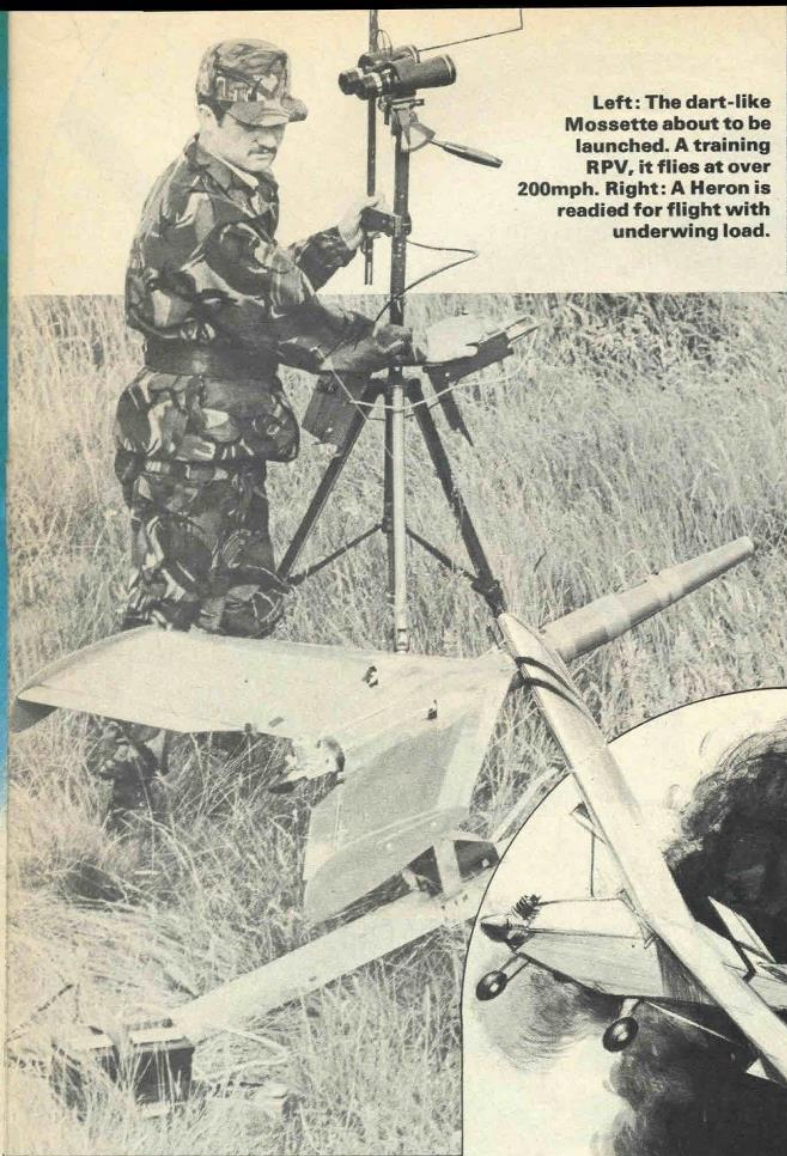
Two delta wing designs have emerged from the AEL drawing boards. The tiny *Merlin* is made of plastic foam covered with plywood and can be used either for pulling a target drogue or it can carry a Robot 35 mm half-frame camera. As a sky-spy the *Merlin* can take photographs from heights up to 3,000ft. In this role it can be used to check the effectiveness of camouflage or spy on a nearby enemy.

The *Merlin's* bigger brother, the *Falcon*, has a wing span of 7ft. 9in. and a 56cc engine which gives it a top speed of 126mph. In addition to the target-towing and sky-spy roles, the little monster can carry six bomblets which can be dropped singly or altogether.

All these little craft are controlled by a VHF transmitter



Left: The dart-like Mossette about to be launched. A training RPV, it flies at over 200mph. Right: A Heron is readied for flight with underwing load.



Top right: An airborne Falcon. This flying wing model can carry up to six small bombs. Right: the models attack! By replacing conventional aircraft, these tiny models could save many lives in a war situation. Opposite page: An Army controller sends a delta RPV on its way.

mounted on a tripod. The operator keeps the aircraft in sight through binoculars and with simple controls guides the craft on its way. However, three miles is about the limit of the visual control of the operator, although plans are in hand to produce a miniature autopilot which will enable the craft to perform tasks beyond this range. Already an automatic height and heading lock is available to simplify the task of the operator.

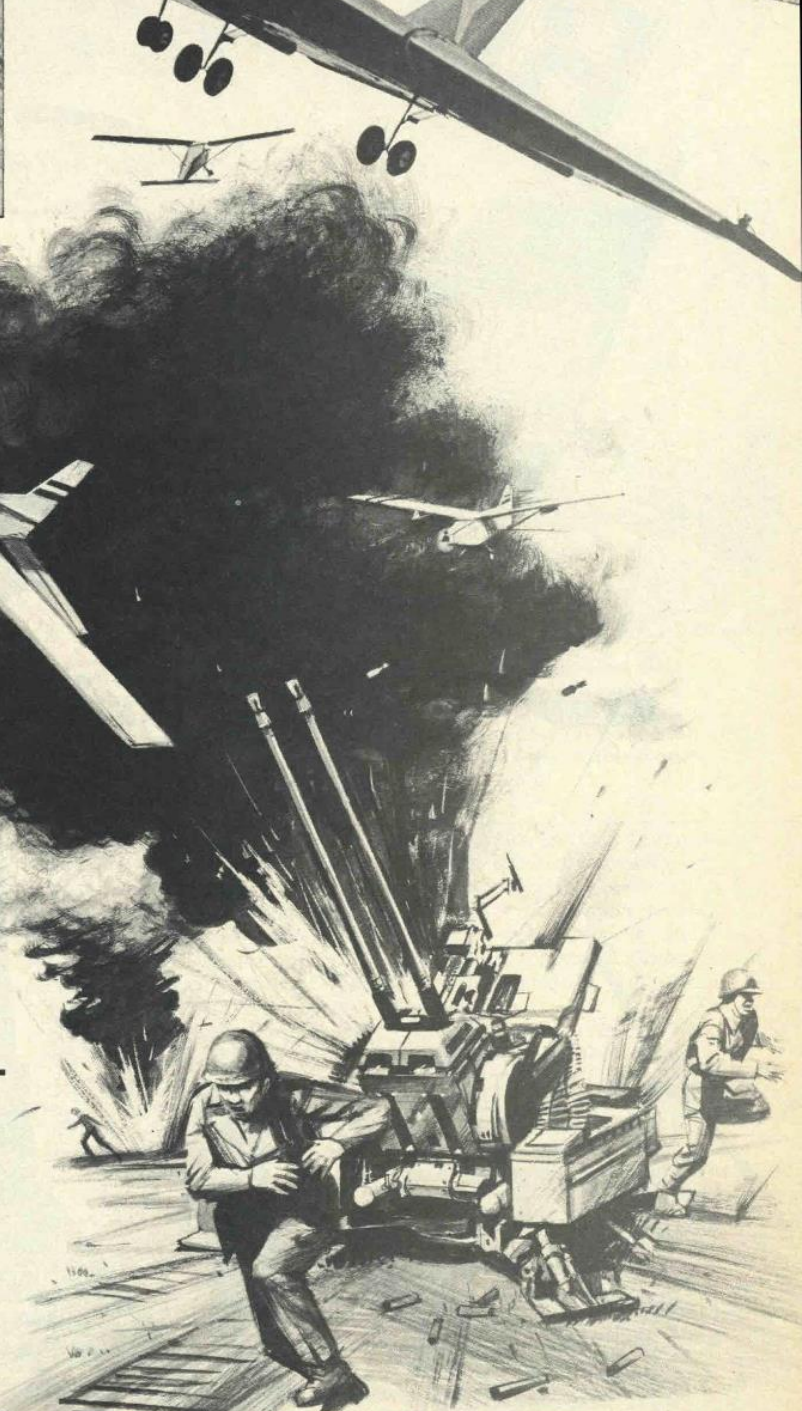
Why produce these odd little craft? Well, just like commercial companies, armies have to do their best to keep costs down. A Mossette can help train a missile operator at a fraction of the cost of firing the real thing. The Falcon and Merlin can take sky photos to provide military intelligence cheaply. The Heron can give target practice far less expensively than any other airborne method. So these innocent-looking "models" are a way of helping modern armies to be both efficient and economical.

**Falcon**  
Span 7ft. 9in.  
Length 6ft. 6in.  
Payload 15lb.  
Engine 56cc.  
Max speed 126.5mph.

**Merlin**  
Span 4ft. 9in.  
Length 4ft.  
Payload 3lb.  
Engine 10cc.  
Max. speed 115mph.

**Mossette**  
Span 4ft.  
Length 3ft. 6in.  
Weight 4lb.  
Engine 6cc.  
Max. speed 207mph.

**Heron**  
Span 9ft. 10in.  
Length 5ft. 11in.  
Payload 30lb.  
Engine 56cc.  
Max. speed 120mph.





# Speed & Power

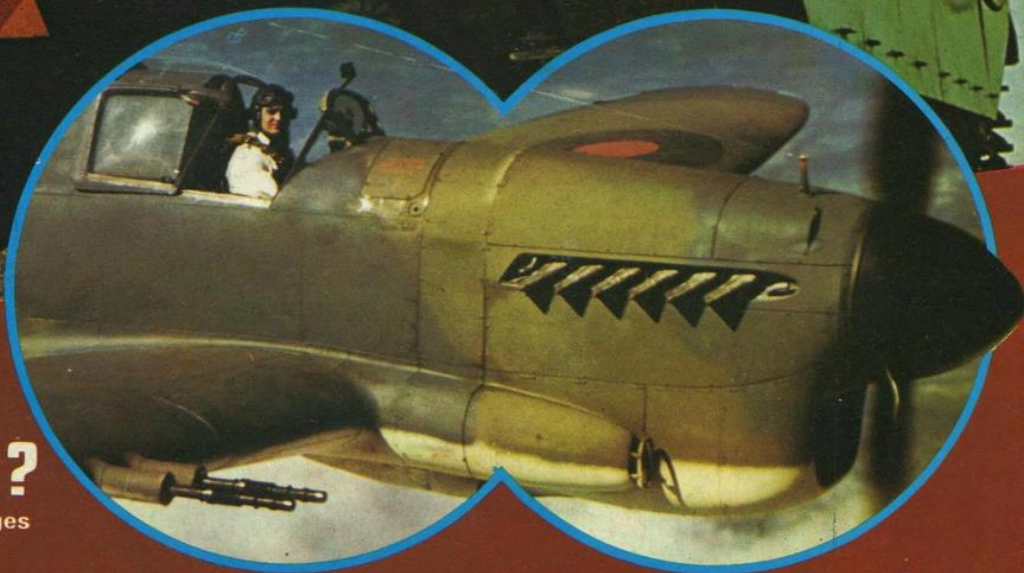
10p  
Weekly  
No. 32  
October 25-  
November 1, 1974

**Great New Series!**  
**Story of the Tank**

**Cars Space**  
**Planes Ships**  
**Science Fiction**

**Which Naval  
Fighter Was This?**

See centre pages







Concorde may have been made quieter and cleaner on take-off or landing, but it could be dangerous if it's too smokey at altitude. Here, a Mini-Sniffer investigates.

# MINI SNIFFER— MIGHTY TASK

**W**ILL HIGH altitude supersonic planes of the future pollute the atmosphere with their jet exhausts? If they do, will this change the world's weather by creating banks of artificial cloud in the stratosphere? Or will chemicals in the exhaust react with the air, and change it so that deadly ultraviolet radiation from the sun pours through to bring an end to living things on Earth?

At present the atmosphere shields us from most of this solar

radiation, but major significant changes in its make-up could expose us to worryingly high radiation levels.

But before you all go digging holes in which to hide from deadly solar rays, we must say that the emission from high flying supersonic planes is likely to be very small compared with that from natural phenomena like volcanoes, which can fling chemical debris right up into the stratosphere. Research and actual tests with aircraft like Concorde have shown

that there is almost certainly nothing to worry about, but with a potential hazard of such magnitude there is no such thing as being too sure.

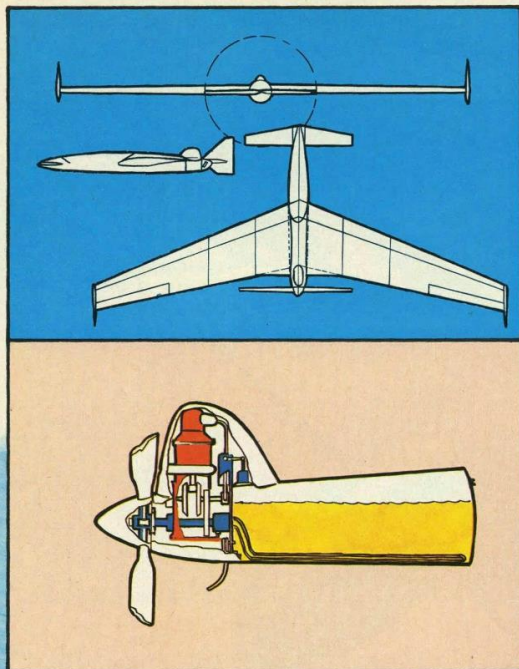
The only foolproof way of telling what a trisonic high altitude plane puts out in its exhaust is to trail it and "smell" the emissions.

Enter the Mini-Sniffer!

As a Lockheed YF-12 research fighter streaks across the sky nearly 50 miles up at 2,000 mph,

**CONTINUED ON NEXT PAGE**





Top: A three-view drawing of the Mini-Sniffer that shows its general shape. It has an 18ft. wingspan and can reach 70,000ft. in 27 minutes. Above: A cutaway of the Sniffer's engine showing the Hydrazine fuel tank on the right, with the two-cycle 15shp engine on the left. At the back is the variable-diameter propeller.

the US space agency NASA will start this autumn to catch a whiff of its exhaust with what is little more than an overgrown radio-controlled model plane called Mini-Sniffer wafting along at between 150mph and 350mph. Its results will be analysed and could tell us for certain whether any restrictions on upper-atmosphere flying will have to be imposed in the years to come.

Mini-Sniffer could also be used to check on what happens to the debris from volcanoes and any H-bombs which might be let off

**Below: The Mini-Sniffer takes off to chase the tail of the Lockheed YF-12 taking off in the background. The RPV will "smell" the exhaust fumes and collect samples for analysis. When its fuel runs out, Mini-Sniffer makes a glide landing under ground control. Far right: A TV camera records what the Sniffer "sees" in the stratosphere.**

above ground. It might also find a role as a communications relay station for soldiers on the battlefield, but specialised remotely piloted vehicles—RPVs—are more likely to be used for that. RPVs take a variety of forms, as we showed in *SPEED AND POWER* issue No. 8, but Mini-Sniffer is one of the simplest and most unusual of these craft.

Built mainly of glass fibre composite, it weighs a mere 145lb and has a payload of 25lb. It combines modern glider construction techniques with those used in advanced types of model aircraft and is controlled in very much the same way as models. The pilot has a set of control sticks which he uses to direct the Mini-Sniffer. The RPV is fitted with a TV camera (in a wing leading edge) to hunt for the smoke trails of the target fighter aircraft whose exhaust is to be carefully sampled.

Climbing to operational altitude of up to an incredible 40 miles following a catapult-launch the tiny aircraft will be tracked by the

"pilot" through binoculars. This will take time and patience, but coming down will be easy—he will put the Mini-Sniffer into a spin and recover from it just above the ground for a glide landing.

The Mini-Sniffer is a back to front aircraft or "canard"—the French word for a duck, which also has its wings right at the back of its body. The Mini-Sniffer is built that way so that its engine can be mounted at the back. This ensures that the Mini-Sniffer's own exhaust is left behind it and doesn't affect the sensitive instruments in the nose which are measuring the exhaust of the target aircraft.

A 40 per cent scale model of the Mini-Sniffer has already been flown and a full size prototype should now be taking to the air fitted with a petrol engine. In the autumn a brand new type of engine using rocket fuel technology from the Apollo moon rocket programme will be fitted to the Sniffer. It's a piston engine but the fuel is pretty exotic. It's called hydrazine and is what is termed a monopropellant. This means that

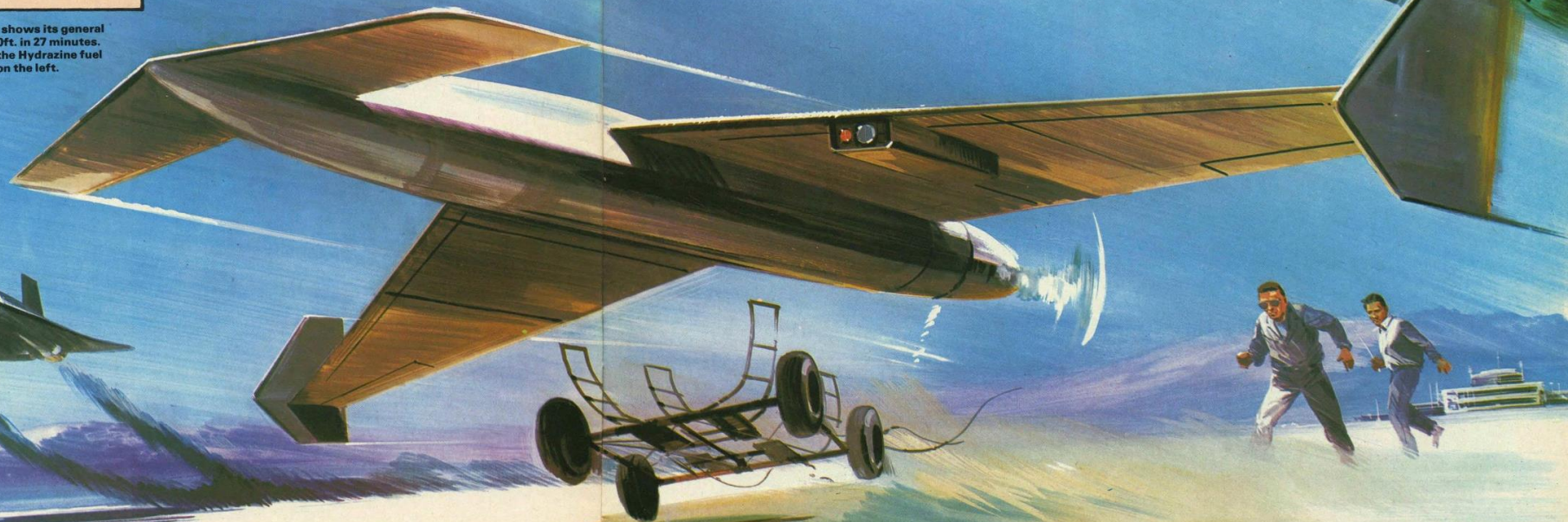
it isn't burnt together with atmospheric air to produce gases which drive it round, but decomposes all by itself when passed over a catalyst to form gases which expand and drive the engine.

Why go to the trouble of developing such a radical engine for a plane like Mini-Sniffer?

The simple answer is that it couldn't fly at much above half the required altitude without it. A normal petrol engine would not get enough air out of the very thin atmosphere at Mini-Sniffer altitudes to enable it to run.

And to let the Mini-Sniffer paddle through the atmosphere at extreme altitudes it has a very special type of propeller which increases in diameter as the plane climbs. So, as the air gets thinner there is more blade area to "bite" at it and push the plane along. The propeller has a little barometer in its hub which is sensitive to the reducing air pressure with increased altitude and lets the prop expand under centrifugal force to a maximum of 5ft. in diameter.

Sniffer may be a mini plane, but its got a mighty task!





# SOVIET SPY SHIPS!



Below: A dramatic moment in November 1970 was when the carrier *HMS Ark Royal* accidentally rammed a Soviet *Kotlin* class missile destroyer that came too close. Above right: Earlier this year, Russian trawlers took a very close look at North Sea oil rigs.



THE RUSSIANS never forgot the lesson they were taught in 1962. That was when the Americans demonstrated total sea supremacy by blockading Cuba and preventing the delivery of Russian missiles. Today, the Russian fleet is on the point of achieving world-wide sea supremacy with a nuclear capability that allows the nation to take greater chances in order to take advantage of her economic and political aims.

The Soviet military masterminds need to know radar, radio, sonar, guidance and control systems used by NATO warships and use radio spy ships and other disguised vessels to monitor frequencies and keep a close watch on exercises. So close, in fact, that they are a danger to ships they spy on.

In November 1970, a *Kotlin* guided missile destroyer passed close to the stern of *Ark Royal* and only a few hours later collided with the carrier while trying to pass ahead. Seven Russians were swept overboard.

In July 1973, three Russian snoopers sailed to within 800 yards of NATO warships on exercise and in 1970, to within 200 yards of the USN *Polaris* submarine *James Madison* as it was about to test fire a multi-warhead Poseidon missile. The firing was cancelled.

Recently it will be remembered that Soviet ships sailed dangerously close to three North Sea oil production platforms to take photographs and measurements. They approached to within 30

yards of one, and 200 yards of the others.

Russian intelligence-gathering vessels were at first converted fishing vessels out for the biggest catch of all—military communications knowledge worth millions of pounds. They attempt to monitor every frequency used by the Allies throughout the world from the nuclear submarine base at Faslane, Scotland, to the communications station on the island of Mauritius, in the Indian Ocean.

The Russians claim they are fishing vessels and can therefore operate within the 12-mile fishing limits. Their sophisticated "ears" are tuned in to catch the slightest whisper. They watch and listen in the English Channel; off the British naval bases at Portland, Portsmouth and Plymouth, sending a steady stream of intelligence back to Moscow.

## HIGHLY TRAINED

The ships normally carry a crew some 30 per cent greater than would be normal for any fishing vessel. These are probably the highly trained operators for the sophisticated surveillance gear which includes long range cameras; sonar listening devices; ultra-high and very-high frequency receiving aerials; direction finding loops; radar scanners; gyro azimuth compasses; and broadcasting or transmitting aerials.

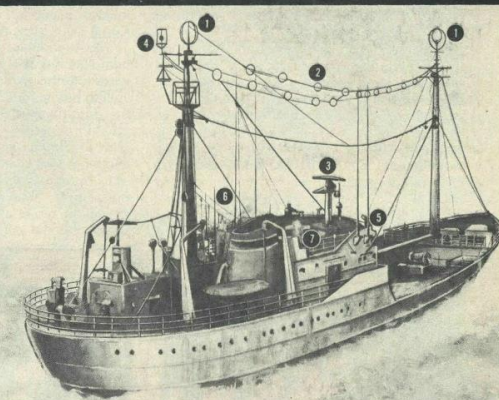
They sit off the Clyde attempting to decode our operational procedures and monitor the patrol pattern of Submarine Command, providing up-to-the-minute information for their own submarines in the area to enable them to track our submarines as they leave the base.

In July this year the Russians assembled a special task force in the Red Sea, allegedly on its way to help clear the Suez Canal. Among their fleet was one of the new breed of spy ships, the 5,000-ton *Primorye*, described as one of the most modern electronic intelligence ships in the world. It is purpose-built for the job.

How the Western Powers go about this sort of "surveillance" is slightly different. Most of our warships have a capability for elec-



The Russian destroyer circling the *Ark Royal* moments before the collision. It is easy to see that the ships are much too close.



A Russian spy trawler. 1. Direction-finding loops. 2. Broadcast receiving aerials. 3. Radar. 4. Frequency aerials. 5. VHF/UHF re-transmitting aerials. 6. Scanner aerials. 7. Gyro azimuth bearing compass.

tronic warfare and if we did have purpose-built ships, where would we station them? The Russian coast is not all that hospitable to visitors and our respect for the international rules for safety at sea would prohibit our operating in the same manner. The *Pueblo* incident a few years back, when an American spy ship was arrested by the North Koreans, taken into port and the equipment thoroughly examined, only served to highlight the difficulties.

But don't imagine that the West is without its own systems of specialist "snooping" divisions, however, whether it be ashore, at sea or in the air. We have, after all, been at it much longer than the Russians!

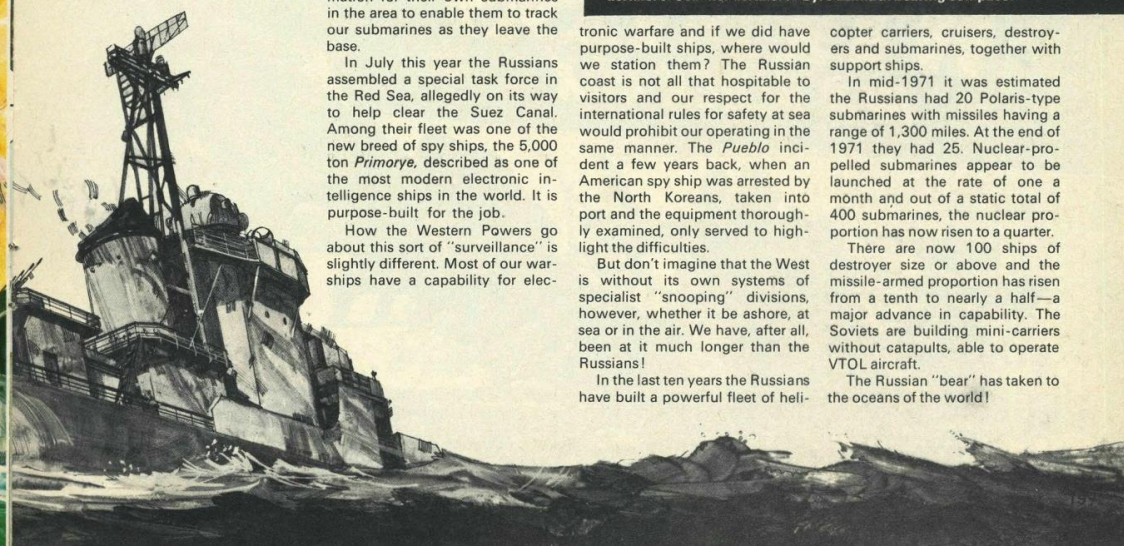
In the last ten years the Russians have built a powerful fleet of heli-

copter carriers, cruisers, destroyers and submarines, together with support ships.

In mid-1971 it was estimated the Russians had 20 *Polaris*-type submarines with missiles having a range of 1,300 miles. At the end of 1971 they had 25. Nuclear-propelled submarines appear to be launched at the rate of one a month and out of a static total of 400 submarines, the nuclear proportion has now risen to a quarter.

There are now 100 ships of destroyer size or above and the missile-armed proportion has risen from a tenth to nearly a half—a major advance in capability. The Soviets are building mini-carriers without catapults, able to operate VTOL aircraft.

The Russian "bear" has taken to the oceans of the world!





10p Weekly No. 33 November 1-8, 1974

# Speed & Power

**Huge, Fast  
Containerships**



**New Series  
THE BRM  
STORY**

**Science Fiction  
Space Cars  
Planes**



**Bikes  
on Spikes**



# UNLUCKY

# 13

The space vehicle was on course for the moon, all systems OK. Then it happened...



Drawing courtesy FLIGHT International

## APOLLO CAPSULE KEY

1. Docking probe. 2. Drogue chute mortar (fires 23,000ft ribbon chute to slow capsule from 300mph to 175mph). 3. Negative pitch motor. 4. Pilot chute mortar (fires at 10,000ft). 5. Optics stowage. 6. Foot pan. 7. Side windows. 8. Couches. 9. Outward-opening hatch. 10. Rendezvous windows. 11. Positive pitch motor. 12. Negative roll motor. 13. Positive roll motor. 14. Cabin pressure control. 15. Oxygen control. 16. Servicing hatch. 17. Fuel tank No. 1 System (titanium). 18. Fuel tank No. 2 System (titanium). 19. Helium tank No. 2 System (titanium). 20. Portable water tank. 21. Personal kit and special kit stowage. 22. Pressure suit stowage. 23. Shock absorber strut. 24. Flashing recovery beacon. 25. Food stowage.

FROM THAT momentous point in world history on July 20, 1969, when Neil Armstrong stepped on to the Moon, the Apollo programme quickly faded in the eyes of the public to routine operation. The start of the third mission aroused so little interest that a 45 minute mid-flight TV broadcast by the crew was largely ignored by the main US TV networks. And five minutes after it ended came that famous understatement that awoke the world to one of the greatest suspense stories ever known. "Hey, we've got a problem."

The flight was that of Apollo 13, an unlucky number for the mission,

but the luckiest number for the three men who were saved by a triumph of technical achievement.

It was almost 56 hours since the huge Saturn V had heaved itself smoothly off the launch pad at Cape Kennedy. The Apollo spacecraft was named "Odyssey", its lunar module, "Aquarius". Apart from a premature cutoff of one engine in the second stage during launch, the flight was routine for the commander, James Lovell. As the world's most experienced astronaut, he was now on his second trip to the Moon. But it was all brand new for his Lunar Module Pilot, Fred Haise, and the Command Module pilot, Jack Swigert,

pulled in from the back-up crew two days before launch to replace Ken Mattingly, who had been exposed to German Measles.

The hours ticked by and the craft crept slowly past the half-way mark in that great gulf between Moon and Earth. Suddenly a dull bang startled the crew into full alertness. They had a problem!

Behind them in the service module were two oxygen tanks, one supplying the three fuel cells to generate electricity. Unknown to anyone, an electric wire within the tank had been damaged during pre-launch testing and had finally short-circuited. Immediately the oxygen tank blew up and a 12ft.

by 6ft. wall panel covering the length of the service module and a fifth of its circumference, was blasted away into space. Cabin alarm signals soon began registering a drop in electric power and in oxygen pressure. The situation was critical.

It was soon clear that all systems in the command module had to be shut down to conserve the remaining oxygen and power for the re-entry into the Earth's atmosphere. So survival became dependent on the air and power supplies of the lunar module alone. The connecting hatch was left open so that both cabins could be inhabited and Lovell and Haise moved in to

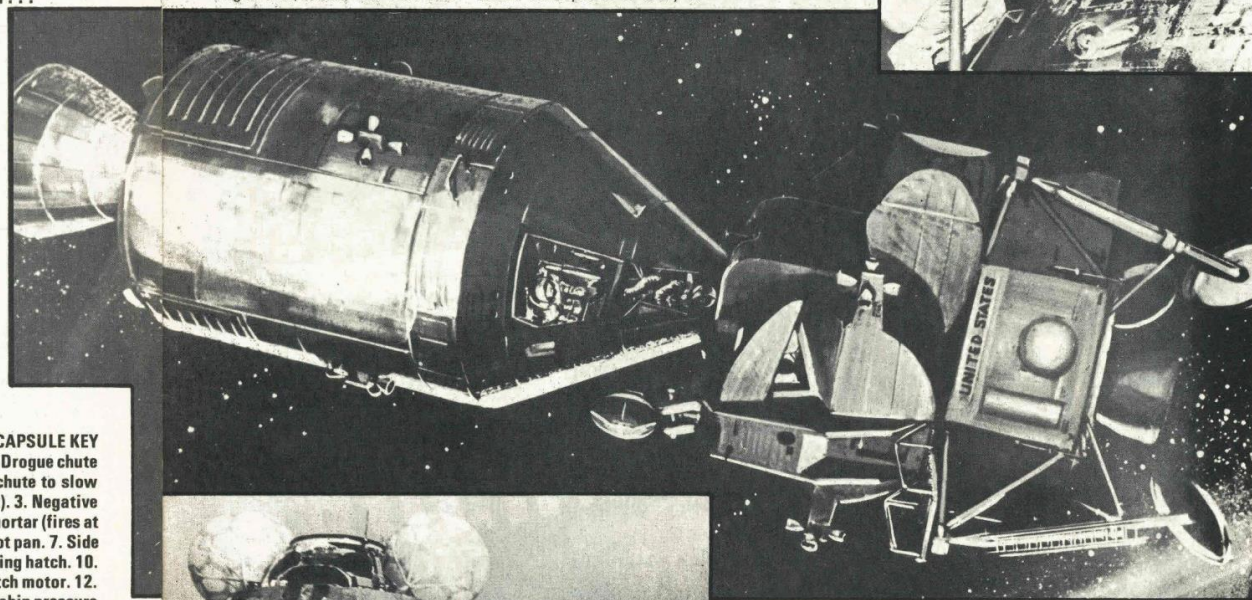
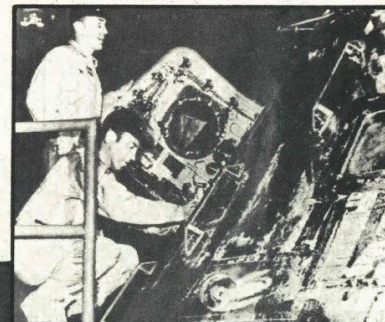
their lunar landing craft for the remaining 88 hours of the flight.

For it was not possible just to turn round and go home—the fuel supply required to reverse direction in space would be inconceivably large. Instead, the three men in the crippled ship simply had to sail helplessly on towards the Moon. Only by slowing itself into lunar orbit and then blasting itself out again at the right time, could the craft turn

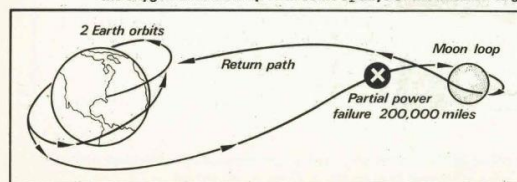
back onto a homeward course. Moreover, the main service engine could now not be used, because of the limited control power, and the risk that it might have been damaged.

There was only the small landing engine of the lunar module to perform the delicate manoeuvres which would bring them eventually back to that precariously narrow re-entry corridor into the Earth's atmosphere. In every re-

Right: The Apollo crew inspect the damage. During the fateful flight, there was every risk that the craft would burn up during re-entry. Below: An artist's impression of the Apollo vehicle with the command module in the centre.



Above: Glad to be back! Astronauts Lovell, Haise and Swigert just after the moment of splashdown. The space capsule "Odyssey" shows its scorched outer skin and flotation bags on top. Below: A diagram showing the Apollo 13 mission of April 11-17, 1970 and the point where the oxygen tank blew up with some 3½ days of the mission to go.



spect, then, the lunar module had become a lifeboat. And if the accident had happened after the LM had separated for landing, or even at any point on the homeward flight, it would almost certainly have proved fatal.

It is not hard to imagine the tension under which the three men lived and worked for 3½ days, not only from the extreme physical discomfort but also from the knowledge that the slightest error in the vast quantity of hasty calculation and replanning would be fatal. Heating had to be kept to a minimum, water was getting low, and only a jury-rigged air purifier was protecting them from suffocation.

At 61½ hours after lift-off came the short burn of the 10,000-pound thrust LM descent engine and shortly afterwards the drama reached its height as the spacecraft swung behind the Moon and out of radio contact. And, while

still out of touch, the astronauts fired the engine again for nearly 4½ minutes to bring them out again and on course for home.

As controllers on Earth sweated night and day on the multitude of new calculations and improvisations, the world waited and prayed and the astronauts in their crippled ship grew steadily colder.

And there was still the risk that a fault or error in the final engine burns could result in too shallow a re-entry and they would bounce back out of the atmosphere and into perpetual solar orbit. Or, if it were too steep, the speed of their re-entry would burn the frail craft to a crisp in an instant. But lunar module "Aquarius" performed faultlessly to the end. And as "Odyssey" settled into the Pacific beneath its three huge parachutes and only four miles from the recovery ship, the world breathed again.

Photos: courtesy USIS





# AEROCRANE

## LOAD-LIFTER FOR THE FUTURE

**T**HE STRICKEN fighter, undercarriage crippled on landing, is slewed across the aircraft carrier deck, preventing other planes from taking off and landing. If this happened today it could be ages before the deck was cleared, but the carrier commander of the future may well have a speedy answer: *send for the Aerocrane!*

Within a short time this odd form of aircraft could be hovering over the carrier, picking up the fighter and actually hoisting it back to shore base for repair.

No wonder that civil and military departments of the United States government are looking very closely at the Aerocrane project, for it could well turn out to be one of the most versatile load-lifters the world has ever known.

The Aerocrane will be a combination of balloon and helicopter. Filled with the lighter-than-air gas, the balloon would be fitted with four wings (instead of rotors as on a helicopter) each powered by a turboprop engine. The gas

An artist's impression of the Aerocrane compared with the world's largest helicopters. At the top is the Russian Mil-12 with a 40-ton payload and below the US Army's Boeing-Vertol Heavy Lift Helicopter, which is still under development, and will be able to carry 22.5 tons. Although it will be slower than the helicopters, Aerocrane will be able to lift a massive 90 tons.

CONTINUED ON NEXT PAGE



# AEROCRANE

would be kept in eight cells. There would be a lightweight tubular metal structure, and internal bracing wires would be stretched between the cells.

The amount of gas would be carefully worked out so that there would be enough buoyancy to lift the entire vehicle, including fuel for the wing engines, plus buoyancy of 40 per cent of the load. The balloon and wings would rotate very slowly and create enough upward lift to raise the remaining 60 per cent of the load.

At the same time, the thrust from the engines could be adjusted and deflected to propel the Aerocrane and manoeuvre it into position.

The vehicle would be piloted from a control cab or gondola directly below the balloon-shaped weightlifter. Fitted into the gondola would be all the necessary engine and flight controls, navigation equipment, radio equipment and life-support functions to suit various missions.

To prevent the gondola from revolving with the balloon or spheroid (as this shape is called) there will be a swivelling joint above the cab. A motor will drive against the natural turning forces so that the pilot will always be kept in line with the flight path.

At the moment tests are under way with a model Aerocrane, built by All American Engineering Company, of Delaware, USA. It has a 15ft. diameter sphere with 9ft. long wings, giving an overall wingspan of 33ft. But really massive ones are planned—with a sphere diameter of 180ft., wing span of 126ft. (an overall wingspan of no less than 432ft.) and a wing width of 21ft. There would be four turboprop engines fitted to the wings, each of 1,500hp.

This monster would be able to carry in a sling as much as 90 tons. The Aerocrane would rotate at over  $8\frac{1}{2}$  revolutions per minute and move forward at 47mph.

Although not being able to travel as fast as helicopters, the Aerocrane would be able to carry

much heavier loads than today's two biggest cargo choppers: one from Russia with 40 tons load capability, and one still under development in the USA, Boeing's HLH (Heavy-Lift Helicopter), with 22.5 tons payload.

Just imagine what this sort of muscle-power could do for us! Houses could be made and assembled in factories then shifted whole to building sites where foundations would have been laid already.

Large numbers of passengers sitting comfortably in de luxe people-carriers could be transported from city centre to city centre, without the need for massive runways. Timber harvesting of remote areas in underdeveloped countries could now become possible, while the Aerocrane could be fitted with massive buckets to reach ore deposits which today are inaccessible.

Containerships could be unloaded at sea and therefore ease the load on hard-worked ports; building roads and bridges could become easier with the services of an Aerocrane; and entire, fully-loaded trucks could be lifted in and out of prime agricultural lands to remove valuable produce at really low costs.

The Aerocrane would also overcome one major disadvantage which normally besets airship designs. When an ordinary airship is "parked" or moored in bad weather, it tends to get blown about and becomes sometimes quite a dangerous handful. But, because of the high reserve buoyancy and the ability of the rotating wings to thrust in any direction to counter difficult gusts, the Aerocrane could be tied down like a balloon, and would be quite stable.

With the US Navy and the US (Government) Forest Service showing an interest, the Aerocrane could well prove just the answer for people with big cargo-carrying problems. In fact, it could take quite a load off their minds, in more ways than one!



Below: A small scale Aerocrane is now under test in the USA. With a 33ft. wingspan and 15ft. diameter sphere, it will "prove" the idea of the larger vehicle before any production is undertaken. The full size Aerocrane would be a boon in remote areas.



Key to cutaway of Aerocrane with 150ft. diameter sphere:

1. Lightweight tubular metal structure. 2. Internal bracing wires between gas cells. 3. Helium-filled gas cells (eight in all) 4. Turboprop engines. (Aerocrane would have four, of 1,500hp each). 5. Control cabin. 6. Wing bracing wires.

The blue arrow indicates the rotation of the spheroid and wings (at about 10rpm) to generate aerodynamic lift at low speeds. When the vehicle is airborne, the turboprops take over. The combined 6,000lb thrust can be adjusted and deflected to manoeuvre the balloon in any direction. Swivelling joints prevent the control gondola from spinning with the main balloon so that it is always facing the direction of Aerocrane's flight path.

Above left: As well as military uses, the Aerocrane could become a quiet, comfortable passenger transport. Here it is shown leaving a heliport of the future. Left: Delivering equipment and clearing the flight deck of crashed aircraft on a huge aircraft carrier would be easy with Aerocrane. Even a loaded attack plane would be a feather weight to the giant lift balloon.



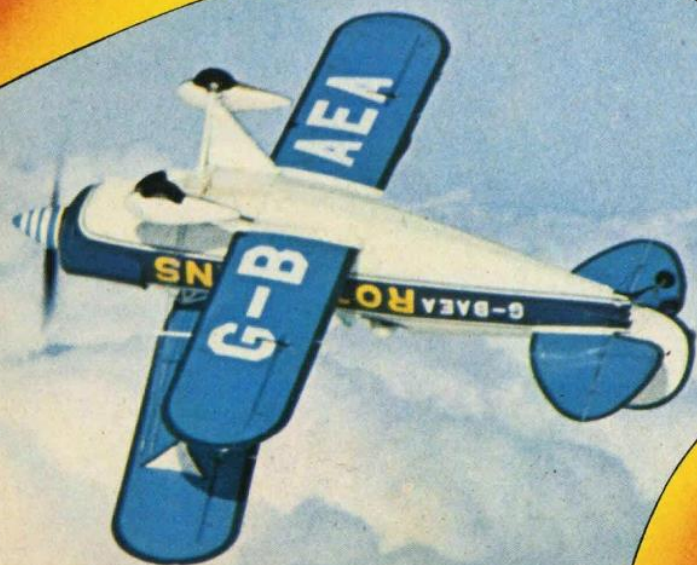
10p Weekly No. 34 November 8-15, 1974

# Speed & Power

**Flying Backwards  
with  
Rothmans**



**Ships Planes Cars  
Science Fiction**



**Inside Story  
Elite of Sports Cars**



# INSIDE STORY

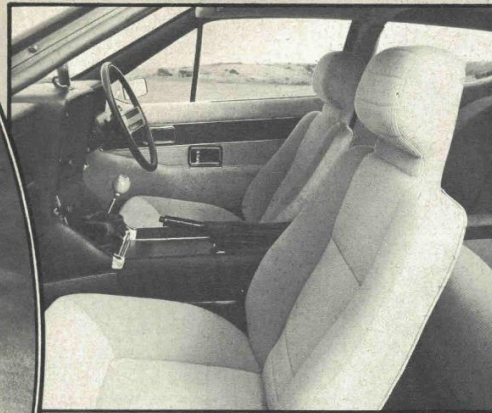


The first Lotus Elite announced by Colin Chapman (right) in 1958.



# A LOTUS FOR THE ELITE

Photos: courtesy Motor and Autocar.



Left and below: The latest wedge-shaped Elite has one of the slipperiest shapes around. Options include air conditioning, radio/stereo tape deck, electric windows, alloy wheels and tinted glass.

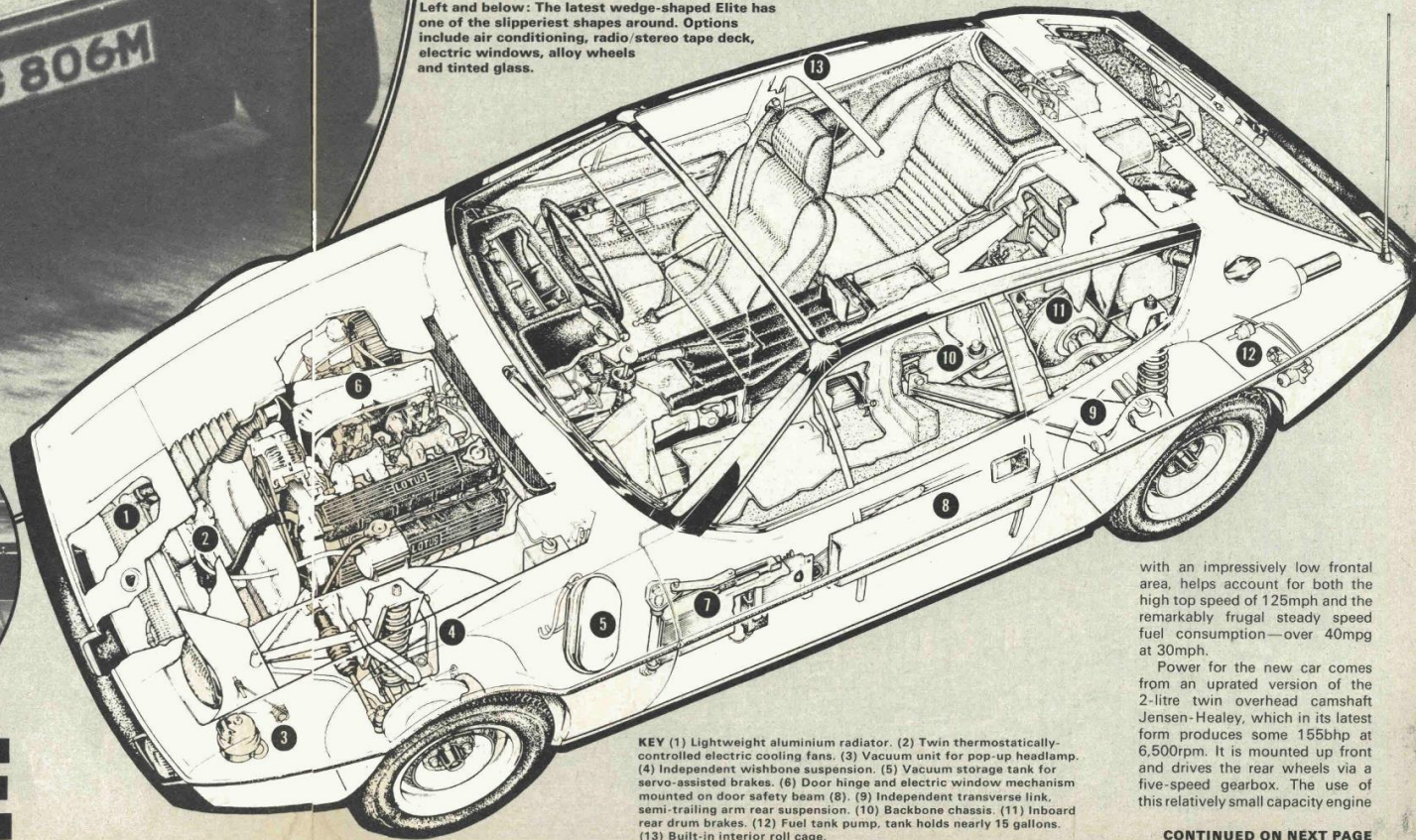
FAMILIAR in name more than nature, the Elite is the latest example of the Lotus march toward the summit of the automobile world. This £6,000 grand touring car is certainly a far cry from the spartan Lotus 6, the model that really set this company on its feet some twenty years ago.

However, this is not the first time that the name Elite has been carried by the Lotus top-of-the-range model. The first one appeared in the late 1950s and this classic of all time is probably best remembered as the first car to have an all glass fibre shell. After the Elite came the ubiquitous Elan, another classic machine, which like the original Renault-engined Europa was the dream of almost every red-blooded youngster. Then came the weeding out process. Lotus was on the move and no longer wanted

to be associated with this class of car. First the Seven, then the Elan were dropped from the books. Now the cheapest car in the range is the luxurious +2S 130 at a cool £3,246.

Despite this slow but deliberate change of face, even the new Super Lotus bears the familiar Chapman hallmarks that have carried Lotus to the top on road and track alike. It has a solid but weight-saving glass fibre skin mounted on a backbone chassis not unlike that of the Elan. A steel roll-over hoop and steel beams in the doors add to the rigidity of this already stiff structure that has sailed through the European safety tests with flying colours.

The Elite's drag factor (a measure of its ability to thrust through the air) is probably the lowest of any car in production and together



**KEY** (1) Lightweight aluminium radiator. (2) Twin thermostatically-controlled electric cooling fans. (3) Vacuum unit for pop-up headlamp. (4) Independent wishbone suspension. (5) Vacuum storage tank for servo-assisted brakes. (6) Door hinge and electric window mechanism mounted on door safety beam (8). (9) Independent transverse link, semi-trailing arm rear suspension. (10) Backbone chassis. (11) Inboard rear drum brakes. (12) Fuel tank pump, tank holds nearly 15 gallons. (13) Built-in interior roll cage.

with an impressively low frontal area, helps account for both the high top speed of 125mph and the remarkably frugal steady speed fuel consumption—over 40mpg at 30mph.

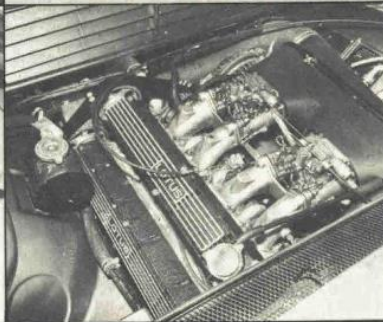
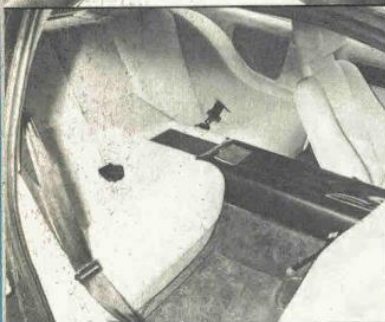
Power for the new car comes from an uprated version of the 2-litre twin overhead camshaft Jensen-Healey, which in its latest form produces some 155bhp at 6,500rpm. It is mounted up front and drives the rear wheels via a five-speed gearbox. The use of this relatively small capacity engine

CONTINUED ON NEXT PAGE





The smooth shape of the Elite is continued right through to the rear window. Single wipers front and rear keep the glass clear. Left: Full instrumentation is standard. Below, left: Four adults can be carried in comfort. Neat retractable seat belts are fitted in the concave rear seats. Below: The engine and its ancillaries take up all the available space under the bonnet.



to drive such a car means that although the flat-out acceleration is pretty impressive and 60mph is reached after 8.1 seconds, full use of the gearbox is needed if other comparable cars are to be kept in sight over winding roads.

To get from 70mph to 90mph, an important speed range when cruising on motorways, the Elite takes over 24 seconds—rather too long to be really safe. Another thing you wouldn't expect to have on a car costing this much money is the noise the engine makes when it's working hard—although to be fair there is still room for development of the 2-litre unit. Yet once the Elite reaches its motorway cruising speed of 70mph in fifth gear it really does whisper along in a most relaxed and effortless way.

The roadholding of all Lotus cars is legendary. The very effective all-round independent suspension of the Elite, plus the excellent extra low profile Dunlop tyres, have given the car even better "grip" than the famous Elan and Europa. Long before the normal driver will get the wheels to "break away" he will be exceeding all normal speed limits—and most likely his personal speed limit, too! The car simply goes in the direction in which it is pointed, ably assisted

by the optional power steering.

Clever adaption of the now traditional wedge design has made the Lotus a full four seater, the seats of which are extremely comfortable. The car is available in three stages of trim, and the most expensive 503 version includes a combined Philips radio/tape system plus recording microphone, an air conditioning system, electrically operated tinted windows and a heated rear screen with wash/wipe control. As usual with current Lotus cars, the driver has all the instruments he needs.

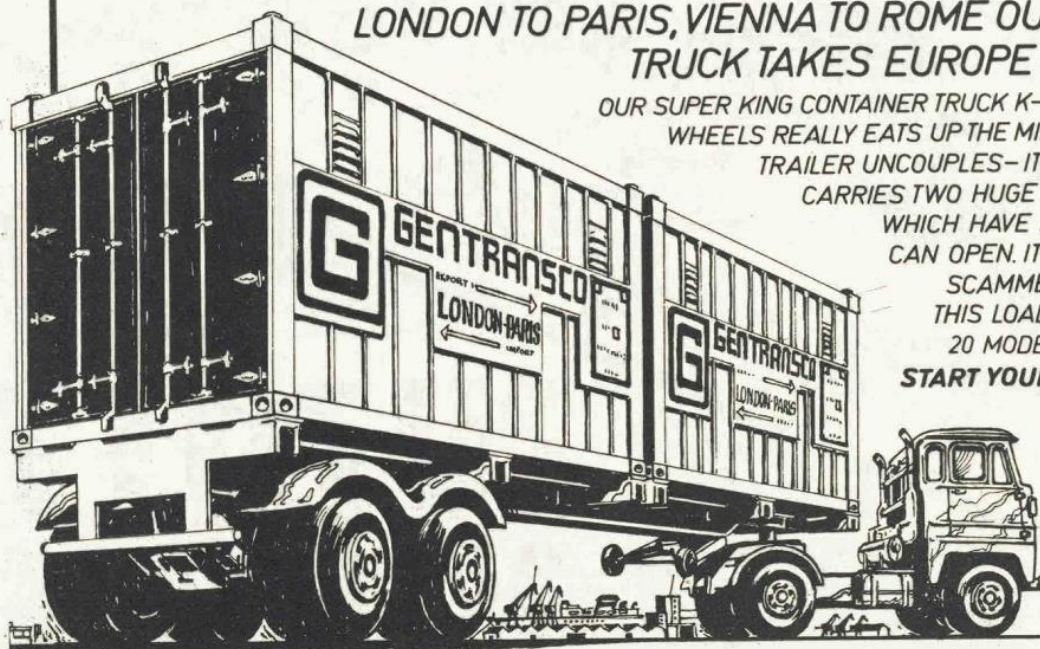
Though the Elite is not bristling with technical innovations it has plenty of as yet uncommon features. Like the Europa it utilises a single screen wiper and like the Elan the headlight pods are vacuum operated. The radiator is constructed of bonded aluminium, another weight saving idea. Even the shell itself is rather special, being made in two halves by a novel resin injected process already in use for the Moonraker power boats (another Lotus product).

Lotus already admit that their future hangs on the futuristic looking Elite. Only time will tell if this move towards the top of the price tree was the right one.

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# BIG JETS GO TO SEA

Some of the latest ships are being powered by giant gas turbine engines similar to those used in jet aircraft!

**S**LOWLY AND deliberately, watching the tachometers and temperature gauges in the complex instrument console in front of him, the Captain opened the throttles. Behind him he could hear the increasing whine as the great jet engines gulped in huge quantities of air while the revs built up to their running speed.

With the engines running to his satisfaction, the Captain looked out of the windscreen to his front, then turned to the First Officer beside him. "Let go everything forward and aft, Mister Mate," he called.

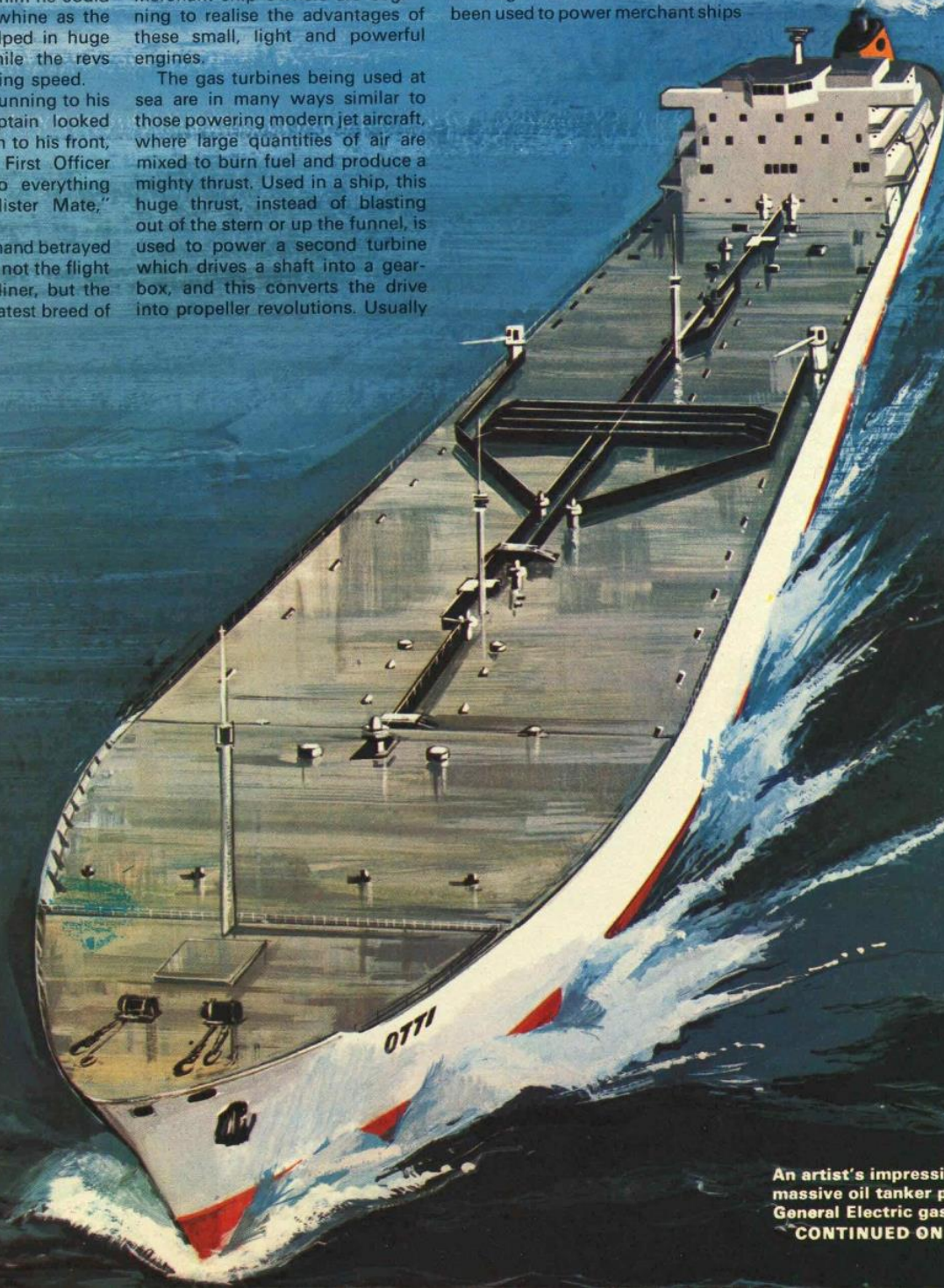
Only the last command betrayed the fact that this was not the flight deck of some jet airliner, but the bridge of one of the latest breed of

cargo ships powered by gas turbines—a new and revolutionary class of ship. With the Royal Navy standardising on Rolls-Royce gas turbines in its new warships, merchant ship-owners are beginning to realise the advantages of these small, light and powerful engines.

The gas turbines being used at sea are in many ways similar to those powering modern jet aircraft, where large quantities of air are mixed to burn fuel and produce a mighty thrust. Used in a ship, this huge thrust, instead of blasting out of the stern or up the funnel, is used to power a second turbine which drives a shaft into a gearbox, and this converts the drive into propeller revolutions. Usually

the engines run at the same speed all the time while the angle of the propeller blades is changed to vary the speed of the ship.

Compared to a steam turbine or the huge marine diesels that have been used to power merchant ships



An artist's impression of a massive oil tanker powered by a General Electric gas turbine.

CONTINUED ON NEXT PAGE 23



for generations, the gas turbine is fantastically small for the power it produces. Indeed, a gas turbine engine capable of producing 30,000 horsepower can be contained in a box only twenty feet long. A diesel able to punch out this power would be a massive unit bigger than a large house and weighing up to 400 tons.

Because of this amazing power-to-weight ratio, the gas turbine needs only a small engine room and much more of the ship can be used to carry cargo and, therefore, earn money. Best of all, the gas turbine is very easy to maintain and only small crews of engineers need to be carried. If a fault develops or the engine is due for maintenance, instead of a whole ship worth perhaps ten million

the air there is little in the environment to harm a gas turbine, but at sea it is a very different picture. The jet engine needs to "breathe in" enormous quantities of air, and at sea it is a considerable problem preventing corrosive salt spray from being sucked into the air intake. To avoid this, air intakes are sited as high as possible, and between them and the engine there is a complex system of baffles, filters and extractors to remove as much of the salt as possible before it reaches the turbines.

To overcome noise problems, gas turbine exhausts are funnelled through a huge silencer system.

What kind of vessels are using this exciting modern form of propulsion?

The latest ships to enter service are a pair of tough trailer ships on the Australian coast. They have been built to spend the shortest possible time in port. Cargo can be rushed out of the great stern door in a matter of hours, and a complete engine change of the gas turbines takes only a little longer.

New ideas for gas turbines at sea could actually do away with the engine room altogether! The gas turbines would be mounted up on the deck, producing electricity. This would be fed into a small propulsion motor driving the propeller. Already a tanker powered this way is being built in America.

The development of gas turbines for use in ships was not all plain sailing, however. On dry land or in

pulsion? The latest ships to enter service are a pair of tough trailer ships on the Australian coast. They have been built to spend the shortest possible time in port. Cargo can be rushed out of the great stern door in a matter of hours, and a complete engine change of the gas turbines takes only a little longer.

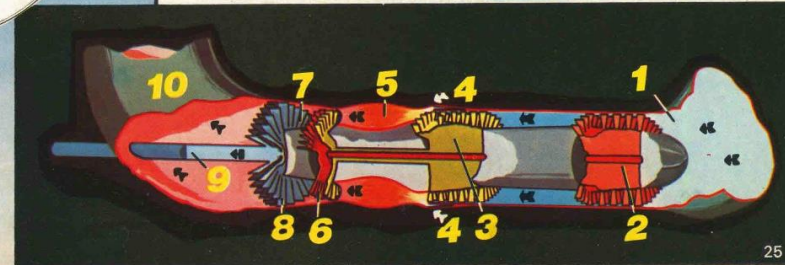
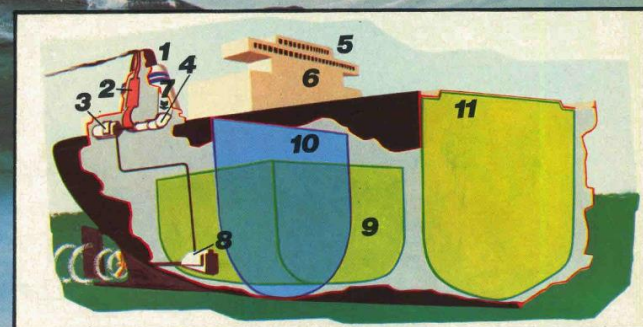
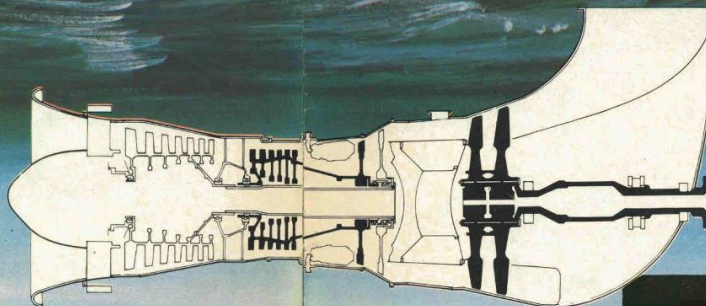
The fastest jet cargo ships running are four high-speed container ships of 28,000 tons which power their way across the North Atlantic at a regular 26 knots (over 29mph), their two huge propellers driven by nearly 60,000 horsepower from two small gas turbine engines.

Above: A marine version of the famous RB.211 aero engine. This has been specially adapted for use in large ships. The principle is shown in the diagram (far right). KEY: 1—Air is filtered through the inlet. 2—Fan sucks air in. 3—Turbine. 4—A mixture of fuel and air is pushed into the gas generator by the turbine. 5—Gas generator. 6—Single

turbine driving fan. 7—Maximum thrust created in this chamber. 8—The power turbine which drives the propeller. 9—Shaft to gearbox and propeller. 10—Exhaust system to funnel. A special air-filtering system is used to stop salt air entering the engine; and at the other end there is an extensive silencer system to reduce noise.

Left: The immense size of gas turbine ships is illustrated in this picture of Seatrain Lines' *Eurofreighter*. The engine is comparatively small, leaving plenty of room for money-making cargo. Below: The ultra-modern *Finnjet* passenger liner, now being planned, ploughs through the waves powered by its incredible 75,000hp gas turbines.

The diagram below shows the amount of space saved by gas turbine engines. 1—Funnel. 2—Silencer. 3—Generator. 4—30,000hp gas turbine. 5—Bridge. 6—Crew accommodation. 7—Air inlet. 8—Electric propulsion motor. 9—Shows the space that would be required for a diesel engine of the same power. The area between numbers 10 and 11 is the space that can now be used for extra cargo because of the compact gas turbine engine.

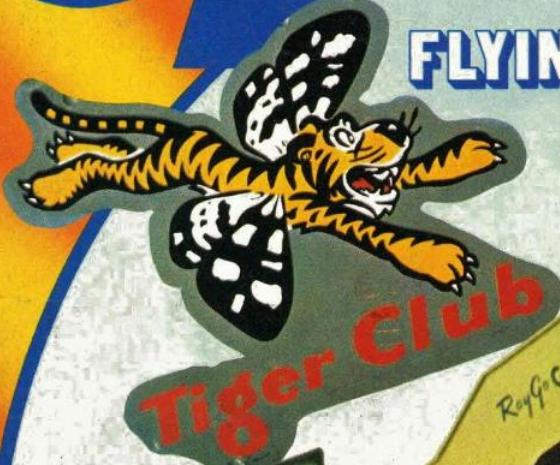




10p Weekly No. 35 November 15-22, 1974

# Speed & Power

FLYING TIGERS



GENTLE GIANT

PLANES  
CARS TRAINS  
SCIENCE FICTION

NIMROD -  
SUB HUNTER  
SUPREME

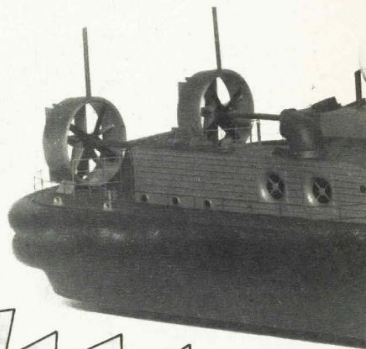




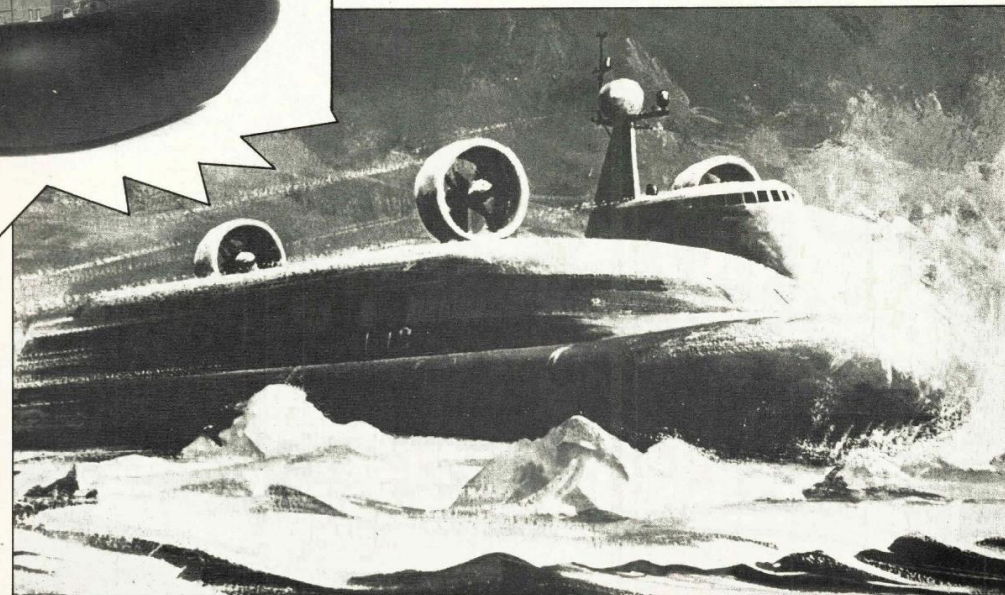
# HOVERCRAFT ICE CRUSHERS

One of the wonders of our technological age is the British-invented hovercraft. Among other things, it has so far been used to ferry passengers across water, ride over marshy land, carry heavy loads over weak bridges, and transport troops at speed over all kinds of otherwise impassable ground. Now it could actually be used to shatter thick ice in the frozen Arctic wastelands.

Below: A hovercraft icebreaker could clear the way for transporting essential supplies to depots set up in unfriendly ice-bound areas, thus making available more easily and quickly all the valuable natural resources in those regions. Right: On board the hovercraft there will be an Obstacle Detection System—radar which will tell the commander if there are any obstructions up to 2½ feet high and three miles away, so that he can decide to ride over or round them.



Left: A model of Bell Aerospace's proposed 170-ton hovercraft icebreaker. Below: An artist's impression of the company's 1,000-ton high-speed design.



IN PLACES like Canada and the Baltic, where severe winters and polar conditions can freeze over rivers and seas, ice-breakers have to be used throughout the winter to keep shipping lanes open to vital ports. These vessels carve their way through thick pack ice by battering it with their specially shaped and strengthened bows, or by using their tremendous power and weight to ride up on to the ice and snap it off.

Now the United States Navy and the Canadian government are testing hovercraft as ice-breakers. Hovercraft are lightweight and low-powered vessels and using them to break up thick ice seems at first sight to be ridiculous. Yet it has been known for years that a hovercraft breaks up ice it passes over, but in an entirely different way from ordinary ice-breaking vessels.

As the hovercraft approaches and rides up over the ice, air in the "cushion" flows between the water and the underside of the ice forming a large air bubble. This means the water is no longer supporting the ice and therefore the ice crumbles under its own weight away from the main floe.

A hovercraft can clear a channel through ice at a speed of 15mph. That's about five

times faster than a conventional ice-breaker vessel. The thickness of ice that can be broken by the hovercraft depends on the air pressure of the hovercraft's cushion, and how much water it can displace with a huge air bubble.

Besides being much faster, ice-breaking by hovercraft is much cheaper. The hovercraft needs to be only a fraction of the size and cost of a ship, has a low engine power, and needs a crew of only four or five. Also, because the hovercraft is a standard machine and not a purpose-built ice-breaker, it can be used in a variety of roles when it is not needed for ice-breaking.

The development of ice-breaking hovercraft is only just beginning and trials are continuing. Their operation will result in the faster clearing of winter shipping routes and will allow ships to move in remote areas which at the moment are blocked throughout the winter months.

The United States Navy's interest in the use of ice-breaking hovercraft is centred on Alaskan Arctic. The terrain in this area consists of pack ice, crevices, open water, tundra and river-beds—conditions on which only an amphibious hovercraft can successfully operate.

The craft will operate on ship-to-shore duties along the Alaskan coast, where the water is very shallow and ice floes make conventional shipping very difficult. Craft will also be used as trans-Arctic transporters and rescue vehicles for submarines making under-ice journeys and aircraft which may crash in ice-bound areas.

The hovercraft will have to be able to operate over the Arctic terrain at high speeds in all weather conditions. This involves temperatures as low as minus 45 degrees F, and very poor visibility. In temperatures as low as

this some materials used to make the hovercraft skirts lose their flexibility and crack. Hydraulic fluids and most lubricants can turn to "jelly" and may have to be heated before the craft could be operated.

One of the advantages of using a hovercraft in these areas is that it causes so little damage to the tundra, the soft marsh-like surface covering large areas of Alaska which is exposed during the summer thaw. It can take up to 25 years for tundra to return to its original state if it has been driven over and scarred by wheeled or tracked vehicles.

Because of the height of some of the ice ridges a trans-Arctic hovercraft will need a much deeper skirt than those fitted to present day craft. However, even with a deep skirt some of the ridges will be too high for the craft to cross. Therefore radar will be used to detect obstacles very early so that the commander can decide whether to cross them or travel around them. It is anticipated that the Obstacle Detection System used will be able to estimate the height of an obstruction to within 2½ feet at a range of 3 miles!

Craft of up to 1,000 tons have been studied during the US Navy's programme and three companies are engaged on detailed designs. Bell Aerospace and Aerojet-General are preparing designs for a craft of 150 to 190 tons, about the same size as the British SR.N4 cross-Channel hovercraft. They will have a cruising speed of 80 knots and a range of 500 miles. The Boeing company is working on a design for an even bigger vehicle, a 500 ton craft capable of travelling 1,200 miles at a cruising speed of 80 knots.

As usual, the development of these craft depends on whether sufficient money is made available by the US Government. If it is, at least one of the craft could be in service within only five years from now.



# GENTLE GIANT

## *carves out a smooth ride*



**M**OTOR graders could be called the maids of all work on the construction site. They are found maintaining haul roads leading to and from the actual project, shaping the undercourses of a new road and making embankments.

In America, graders are also used on vast mine and quarry projects, smoothing out working areas and clearing rock resulting from blasting operations.

To cope with the volume of work arising in such locations, RayGo International, of Minneapolis, designed and manufactured the Giant, a motor grader weighing 50 tons and more than twice the length of any found in Britain.

Consider a standard bulldozer of the type you might have seen on any building site. That bulldozer could pass comfortably beneath the boom carrying the grading blade on the Giant!

The machine's blade is 20ft. wide and it can level up to 4,000 cu. yd. (5,500 tons) of earth an hour. An articulated front power unit offsets left or right, and varies the angle of the blade up to 30 degrees in either direction.

### TRENCHES DUG

When it is fully offset, the blade reaches 10ft. outside the front wheels. Furthermore, the grader is versatile and, by tilting the blade, trenches up to 30in. deep can be dug.

Obviously, all this strength needs plenty of power to harness it. Thus, the Giant carries two diesels, each of 318hp. The engines are coupled to a three-speed forward and reverse air-shift transmission and a heavy duty planetary axle.

Hydraulic and accessory power is provided by the forward engine,

while the rear engine gives the pushing power required for the 8,000lb blade.

Not only does the machine level the ground, it can also mix the soil, giving the intermixture of materials and moisture preferred by construction engineers.

According to the men who drive motor graders, operating the Giant is simple—and comfortable. The driver reaches the big, enclosed cab via a safety-railed staircase, and the cab is located behind the blade for easy riding.

### RIDING-ON AIR

More comfort comes from the air-suspended, foam-padded bucket seat. Precision hydraulic-mechanical servo-steering gives feel and response similar to a saloon car. Also, there is independent front and rear steering, which makes turning effortless, and a

very short radius is needed for directional changes.

More than a dozen of the machines are working in North America, and there are also two of them operating on the Marimondo Dam scheme in Brazil.

An interesting use of the Giant was at the Anaconda Open Pit copper mine in Montana, USA. Originally, the intention was for the machine to maintain the area where material was dumped, but wider uses were found. Haul road maintenance, new road construction, maintenance of the benches (levelled-off seams), cleaning up of the blasting area and ploughing snow, were all tasks for the Giant.

Spectacular blasting took place at the mine every day. Following the blast, many hundreds of yards of road became impassable as they buckled and heaved and were strewn with rock. The job for the Giant grader was to clear away

the loose rock, slice off the humps and fill in any depressions.

In spite of the tough nature of the work, the machine was able to ensure that the road was open for mine traffic within the hour.

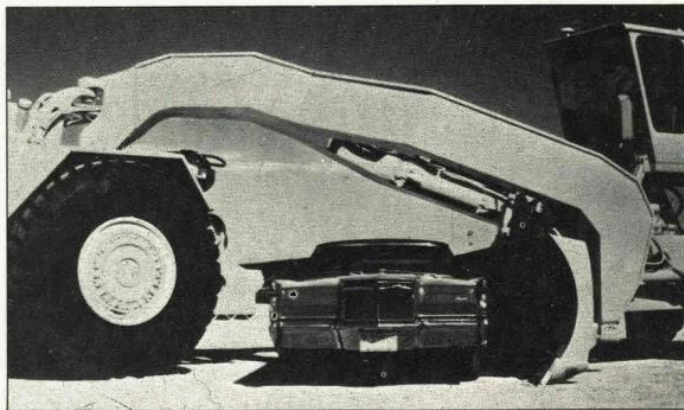
Roads at the mining area are of great importance to the smooth running of the operations. There are 25 miles of haul road with a minimum width of 90ft. To keep up the production schedule, and keep tyre costs down, it is necessary for all road surfaces to be kept in as smooth a condition as possible. Here, the Giant showed its abilities with its wide blade and high ploughing speed. It cleared the 25 miles of haul road of snow in five hours—normally the work of four normal motor graders.

So apart from clearing, in one pass, a path wide enough for the largest hauling trucks, the Giant's ploughing ability also contributed to a reduction in winter working accidents.

Giant was also called in on the Great Canadian Oil Sands project, Alberta, Canada, where its job was levelling and compacting fill material on a settling pond dyke. Material was loaded in the waste-removed area by loading machines, while dump trucks transported the fill material and placed it on the dyke.

The dumped material was knocked down by bulldozers, after which it was levelled by the Giant. Something like 4,000 cu. yd. an hour were levelled and compacted.

The Giant proved to be a tough machine. During the 1,530 hours of total operation on the project, it was available for use for 99 per cent of the time. In other words, for only one per cent of its working time was it out of action for repairs or maintenance, something which few machines used on this type of work can claim.



**Not the best place to park your car. This large American saloon gives you some idea of just how big the scraper blade and the wheels are on the RayGo Giant.**



Fast motorway driving depends on a firm, smooth road surface. Yet, before that standard of perfection can be reached, a lot of hard work must go into the construction of the road. One of the machines used in the early stages of road building is the motor grader and, in the United States, they build them really big — up to 50 tons in weight.



#### GIANT'S STATISTICS

|               |                                                        |
|---------------|--------------------------------------------------------|
| Engines       | 318hp diesels front and rear                           |
| Transmission  | 3-speed forward and reverse, air shift, front and rear |
| Tyres         | 33.25×35/20 PR, front and rear                         |
| Brakes        | Air-actuated drum type                                 |
| Length        | 46ft.                                                  |
| Width         | 12ft. 8in. (without blade)                             |
| Height        | 13ft. 10½in.                                           |
| Wheelbase     | 26ft. 10in.                                            |
| Blade height  | 4ft. 3in.                                              |
| Blade width   | 20ft.                                                  |
| Blade weight  | 8,000lb.                                               |
| Maximum speed | 22½mph                                                 |





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# Speed & Power

**MOSS AT  
MONACO**

*In a Car  
of Character*

**FIGHTER  
OF THE  
FUTURE**

**RECORD-SMASHING  
CONCORDE**

**CARS  
TRAINS PLANES  
SCIENCE FICTION SPACE**





Have you ever wondered what it is like to go into space? Soon, NASA's new space shuttle will begin regular return flights to orbit carrying scientists on missions lasting between seven and thirty days. If you are hoping to become a scientist, one of them could be you. So join **SPEED & POWER** on an exciting . . .

# SPACE MISSION

Part 1

**T**HE KNOT OF tension in his stomach was growing as the launch complex loomed larger ahead. The complicated-looking service tower contrasted strangely with the smooth cluster of pointed cylinders snuggling against it.

That gleaming cluster was *his* shuttle, *his* spaceship. That very thing was going to take

him *up there* far out into the unknown.

He looked at his three fellow scientists seated around him in the minibus. Their faces revealed little, but he knew they must be feeling similar tension. Behind them the two experienced pilots and the flight engineer—"systems monitor" they called him—were talking quietly. All seven wore spacesuits, the helmets resting on their laps.

He had felt irritated all through the last





hectic week. He and his colleagues were called "non-space-trained scientists". Untrained indeed! The six weeks of "acclimatisation" that the four of them had endured seemed longer and tougher than all his years of academic study. And now, with 42 whirling, floating, exercising, cramming days behind him, this "promising young physicist" had only seven days in space to justify it all. He was just 26.

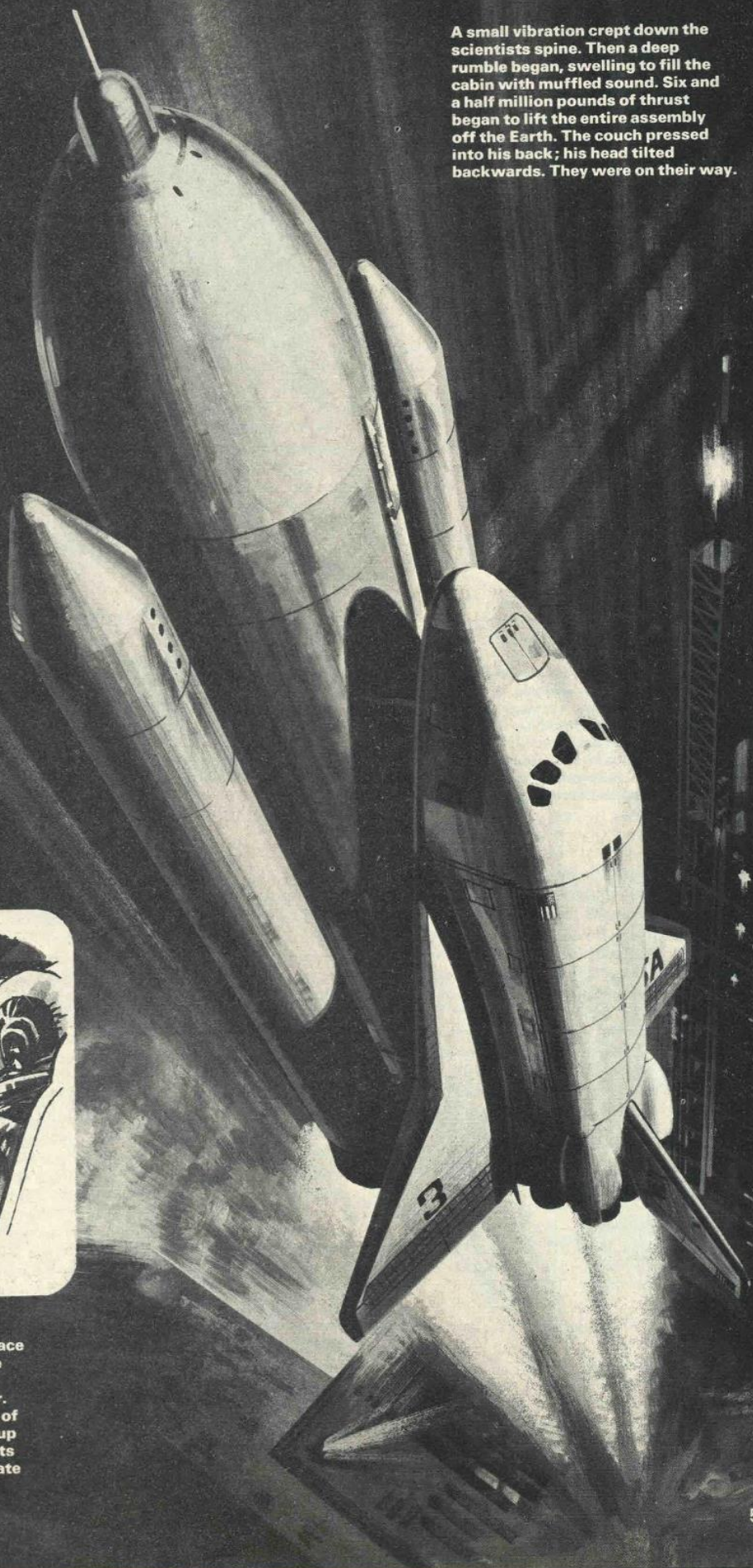
Aboard the shuttle his mind was blank as he lay firmly strapped and plugged into the contoured couch, facing skywards with the ship. Idly, he began to pick out the cabin features so familiar from those hours in the simulator.

The four of them sat in a row along the rear wall of the large, rectangular cabin. He could just see some of the service tower through the flight deck roof windows over the hatch above his head. The windowless cabin before him was partitioned off forward into a bathroom and a galley. He wondered what his zero-gravity dreams would be like as his eyes fell on the eight sleep-restraint "beds" attached to the padded walls of the main chamber.

## NO SOUND

His helmet was clipped to the side of his couch. A headset rested on his knee. There was no sound other than the soft whine of gyros, the taint hum of the auxiliary power unit and the muted voices of the crew as count-down checks proceeded. He donned his earphones in time to hear the captain's voice announce five minutes to lift off. There was no need to check whether he was all right. Wires attached to a dozen parts of his body were telling ground controllers more about him than he would ever know himself.

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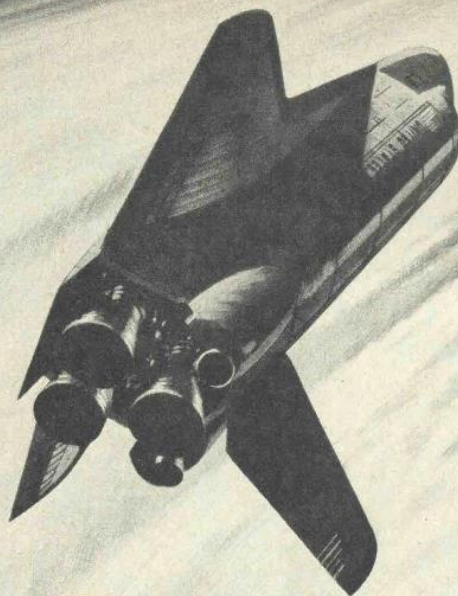


A small vibration crept down the scientists spine. Then a deep rumble began, swelling to fill the cabin with muffled sound. Six and a half million pounds of thrust began to lift the entire assembly off the Earth. The couch pressed into his back; his head tilted backwards. They were on their way.



Left: The young scientist felt just the same slight tenseness, a similar expectant thrill, as those early space pioneers must have done many years before. From the minibus he looked at the gently curved space shuttle and rockets snuggling against the stark service tower. Aboard the shuttle (above) he heard the muted voices of the crew going over the myriad of details which made up the countdown checks. Wires attached to a dozen parts of his body were telling "control" all about him. Too late to back out now . . . He was going into space.





**The fuel tank was jettisoned and, now just an empty useless shell, it began its 17,000mph plunge back into the Earth's atmosphere, turning into a vast molten fireball from which just a few pieces might eventually splash into the ocean 125 miles below.**

The intercom stayed on and countdown continued remorselessly. He made out faint clunks as service arms separated. "T minus three," intoned his earphones. Automatic launch sequence was initiated. Too late to back out now! It was really happening. He was going into space . . . . .

A moment's panic seized him. The neat cabin belied the existence of the vast area of machinery around and below him, the hundreds of highly trained men staring at screens underground a mile away, the enormous complexity of the entire operation. "Get a grip on yourself!" his mind shouted, "This is routine. THIS IS ROUTINE! It's 1983," he said reassuringly. "Men have been doing this for 22 years". Even this new shuttle had been in service for two years, doing the same thing every few weeks.

"T minus one minute."

"Here we go," he thought, and tried counting seconds.

## DEEP RUMBLE

Then there was a small vibration creeping down his spine, growing, growing, until his tensed white fingers seemed to expand with the movement. And then a deep rumble began from nowhere, swelling to fill the cabin with muffled sound.

Suddenly his mind saw the inferno that was

developing far below him, the searing flame from the two vast, 12 foot-diameter solid-fuel boosters mingling with the blast from the torrent of burning hydrogen that belched through the three nozzles of the shuttle's own engines. Six and a half million pounds of pure thrust to lift the entire assembly off the Earth.

He did not feel the first movements, his senses dulled by the noise and vibration. Then slowly, almost imperceptibly, the couch began to press hard against his back. Presently he felt his head tilt backwards and he saw a misty coastline swim into view as the ship began to curve over on to its steep, upside-down trajectory. And then a kind of relief crept over him and somehow he felt the worst was over, like when an airliner settles down into the climb after take-off. They were on their way.

The rumble had faded to a faint hum, more felt than heard. There was no way of telling just when they had gone supersonic. Even the force of the couch pressing his back with a constant 3gs of acceleration grew almost comfortable. Until suddenly it seemed to sink under him and the ship gave a slight shudder. Booster burn-out and jettison. He thought of the recovery vessel below—25 miles below now—waiting in the blustery Atlantic just for their sake, waiting to pick up the boosters which must be already visible by the huge parachutes billowing above them.

Minutes crept past without him noticing,

and the trajectory had flattened out to a shallow angle. The acceleration still made him feel that he was flat on his back. Through the window above him the Earth had become a mottled white ceiling.

"Thirty seconds to orbit," the captain's voice burst in on his thoughts. He glanced at the chronometer on the forward bulkhead. Not even 12 minutes since lift off! Then all vibration suddenly ceased.

## SEARING HEAT

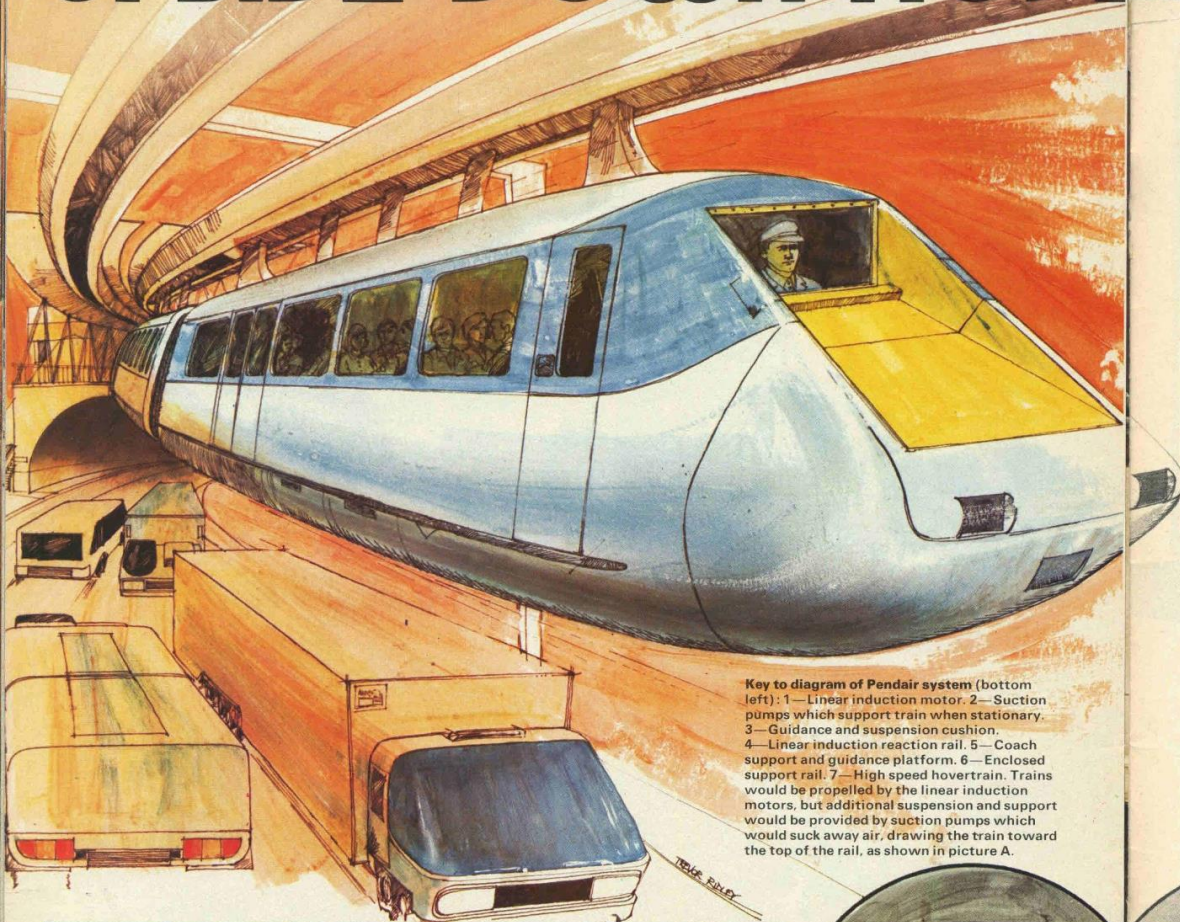
He heard the co-pilot's voice confirming fuel tank jettison and he tried to imagine that vast cylinder, now just a useless empty shell, beginning its 17,000mph plunge back into the atmosphere, the searing heat from the friction rapidly turning it into a molten fireball from which a few small pieces might splash unnoticed into the ocean 125 miles below.

Then he thought of himself, now travelling at 17,500mph. He had never felt so still. They were in orbit. He felt the same wondrous expectation as the early space pioneers must have had on their historic flights.

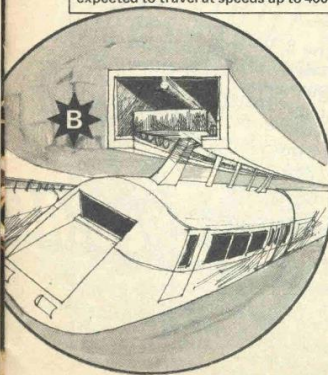
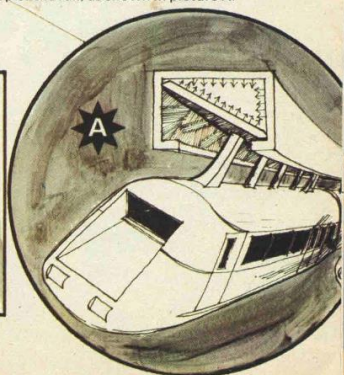
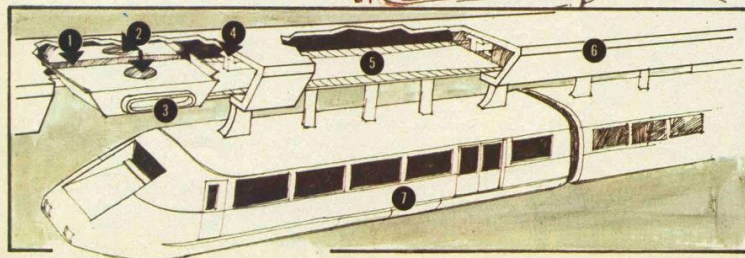
***NEXT WEEK: The scientists start their work, cramming into just seven days all their years of study. Then something goes terribly wrong . . .***



# UPSIDE-DOWN HOVERTRAIN



**Key to diagram of Pendair system (bottom left):** 1—Linear induction motor. 2—Suction pumps which support train when stationary. 3—Guidance and suspension cushion. 4—Linear induction reaction rail. 5—Coach support and guidance platform. 6—Enclosed support rail. 7—High speed hovertrain. Trains would be propelled by the linear induction motors, but additional suspension and support would be provided by suction pumps which would suck away air, drawing the train toward the top of the rail, as shown in picture A.



**I**F THE conventional railway train, whether the long-distance express or the suburban commuter, is to regain its proud status as the king of transport systems, it must do two things. First it must increase its speed, and the second it must make itself independent of delays due to bad weather conditions, flooding of the track, or deep snow.

There is a limit to the speed at which a wheeled train running on a track can travel. And that limit is imposed by the train's wheels, and the track on which they run.

When one object moves across another which is stationary, friction is created. And the more rapid the movement of the moving object, the greater is the friction.

In the case of a railway train, friction between wheels and track acts like a brake and slows the train down. Another effect of friction is to generate heat between wheels and track. And that heat means a lot of wear and tear on wheels and track.

Metallurgists may discover new and harder metals less liable to friction's wear and tear than the ones now in use. But the bug-bear still will be friction's brake on speed.

From the data provided by computers, railway scientists are convinced that a wheeled train running on the conventional track is unlikely to exceed a service speed of much more than 250 miles an hour. Increasing the

**Could this be a high street of the future? A fast inter-city hovertrain speeds along a suspended rail at over 300mph, while road traffic carries on undisturbed below. It is possible that ordinary railways could be replaced by faster systems like this in years to come.**

An alternative to air suspension is ordinary wheels on either side of the rail, shown in picture B. But this would tend to slow the train down and place great strain on the support rail. Bottom right: The pendulum-like link between the trains and rail helps the coaches "keep their balance" as they speed round curves. This makes the ride more comfortable for passengers and reduces the risk of a derailment. Trains like this can be expected to travel at speeds up to 400mph.

power of locomotives, whether diesel, electric or gas-turbine, will not solve the problem. There is a maximum speed at which the fastest train must be slowed down by the braking action of friction.

Railway designers and engineers are convinced that there is only one way to lift the speed limit of friction imposed on the conventional train. To travel much in excess of 250mph, trains will have to get rid of the wheels and rails they now use. And that is exactly what many forward-looking railway designers are now trying to do.

## FASTER SPEEDS

One such idea is the Pendair transport system now under development by a British firm of engineers. Not only does Pendair promise to increase train speed by reducing friction, but the track used is proof against any delays to trains through bad weather or obstacles on the line.

The Pendair track consists of a single girder in the form of a hollow box. Along the whole length of the bottom of the box is a slot. The girder "track" is carried high above the ground on pylons.

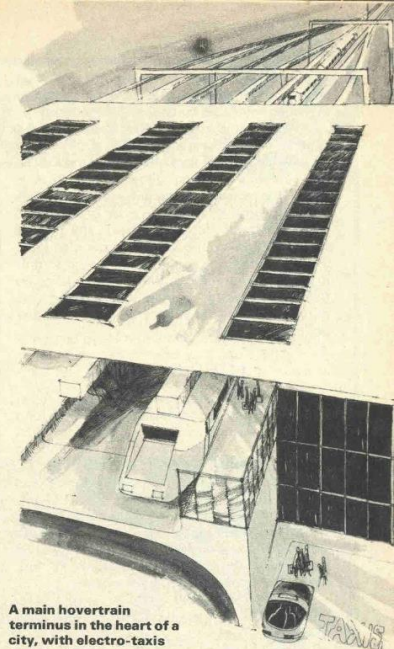
Mounted on top of each coach is a steel, oval-shaped rod which passes through the slot in the bottom of the girder track and is hinged to a kind of trolley. This enables the coaches to swing from side to side like the pendulum of a clock (see diagram).

On each side of the trolley there are small wheels which fit into grooves running along the sides of the hollow girder. These wheels are driven by electric motors on the coaches and take current from a narrow conductor rail running the length of the "track".

## LITTLE FRICTION

While the train is travelling, there is very little friction between train and track. In fact, the contact between the wheels and the track is just sufficient to keep the train moving at speed.

The main support for the train is achieved by what is called "magnetic levitation". In other words, the trolleys to which the train is



**A main hovertrain terminus in the heart of a city, with electro-taxis waiting for passengers.**

attached are suspended in the hollow-girder track by means of a strong magnetic field.

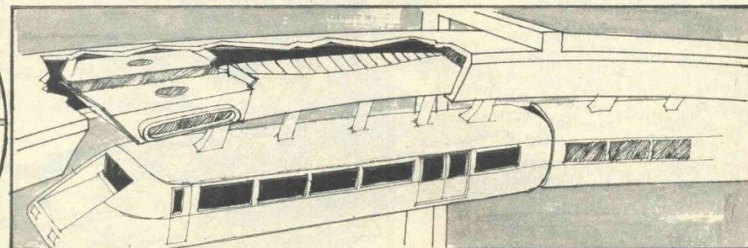
Magnetic levitation is based on what is called magnetic repulsion. This is a natural force created by the like poles of magnets repelling each other.

You can see magnetic repulsion in action if you place two bar magnets close to each other so that the south pole of one is facing the south pole of the other. The two magnets will not be attracted to each other as you might expect. Instead, they will tend to push each other apart.

That is exactly what happens between the side walls of the girder track and the trolleys from which the train is suspended.

Above the suspension trolleys is a conductor through which passes an electric current.

**CONTINUED ON NEXT PAGE**





This current induces or creates around it an electro-magnetic field. Magnets on the bottom of the trolleys also create an electric field.

The two magnetic fields push or repel against each other so that the trolleys are suspended inside the box-girder track. The only contact between girder and trolleys is where the wheels on the sides of the trolleys run in the grooves along the sides of the girder.

The magnetic force that holds the trolleys suspended inside the hollow girder also keep the train centred. Should the train tend to drift to one side or the other, the magnetic force on the side towards which the trolleys are drifting increases in strength. This pushes the trolleys back on course.

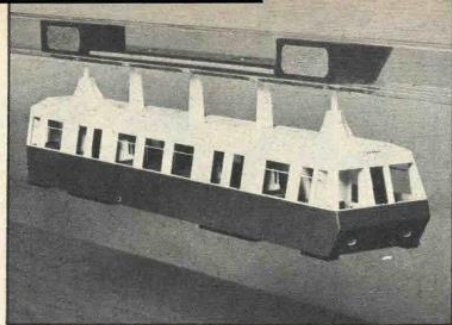
## LONG CURVES

Another restriction on the speed of conventional trains is the need to have very long curves for cornering. Even so, the train must reduce speed when taking curves and so increase its running time.

Taking a curve at too high a speed not only runs the risk of the train jumping off its rails, but it is very uncomfortable for the passengers.

With a Pendair train the risk of derailment and any discomfort for passengers is reduced to a minimum by the pendulum-like link between the coaches and the trolleys.

When the train takes a curve at high speed, the hinged linkage between trolleys and



**A model of a Bliss-Pendair vehicle now being developed. This system could be adapted for either city centre rapid transit or high speed inter-city transport running above the countryside.**

coaches enables the latter to keep an "even keel". At the same time the outward swing of the coaches is countered by banking the girder track. This reduces the outward swing of the coaches and the consequent strain on their linkages with the trolleys.

When the train stops at a station, the coaches are held level with the platform by suction discs on top of the trolleys. These discs have a kind of extractor fan. That is a fan which pulls air towards it instead of blowing air away from it as does the ordinary fan.

The fans suck away the air between the tops of the trolleys and the roof of the box girder. This creates a partial vacuum which draws the discs against the roof of the box girder and holds them there.

Before the train starts again, the fans are

switched off and the magnetic fields again support the trolleys.

An alternative method of driving a Pendair train is to replace the wheels on the sides of the trolleys with a propeller on the rear of the last coach driven by a gas turbine. The train would then be entirely supported by the trolleys suspended in the magnetic field inside the box-girder track.

Another alternative means of propulsion is a jet engine at the rear of the last coach. Unfortunately this would be much too noisy unless some effective silencing system could be evolved.

## SAFETY

Experiments with model Pendair trains encourage engineers to believe that the trains could operate in complete safety at speeds of between 350 and 400mph!

Another advantage of Pendair trains, particularly for suburban commuters, is that the girder track could be carried over existing streets, roads and motorways. This would speed up journeys from home to work, and also avoid the high cost of purchasing land on which to lay a ground-level track.

Delays due to bad weather or obstructions on the track would be avoided because the "track" would be completely enclosed in the box girder. The Pendair system is certainly something we may see in the future.

**ANSWERS TO QUICK QUIZ:** 1—1,320mph. 2—18 tons. 3—Yes, the Vickers Medium. 4—100. 5—Eight. 6—One; HMS Engadine. 7—Beaver. 8—Five. 9—Isle of Skye. 10—Cloudburst—the others are aircraft!

# EXTRA! EXTRA! EXTRA! SPEED & POWER CHRISTMAS SPECIAL

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## STMAS SPECIAL

Your regular issue of **SPEED & POWER** will, of course, be on sale as usual during Christmas week.

**SPEED & POWER**



# Record-Smashing CONCORDE

Join us in the fantastic Concorde, flying at nearly three times the speed of sound, shattering records the world over

UNLIKE roads, highways of the sky can be arranged just anywhere. The sky goes everywhere, so airlines can be sent along whatever route is judged the best to get from one place to another. But in practice it is not as easy as this.

The world's system of airways is grouped into several types of route. Over busy areas of land, pilots have to keep to accurately arranged "airways" which are provided with many radio beacons and other navigational aids. When they are flying these airways they cannot take a direct route but must fly down one airway, turn a "corner" into the next, and so on to their destination. Over the oceans or deserts it is different. Here captains can work out their own best direct routes, though while they are over busy routes such as London to New York, each airliner must still keep to its allotted airway and avoid other traffic.

## SUPERSONIC ROUTES

Now we have yet a third type of air route: the supersonic routes, which are being planned for the Russian Tu-144s of Aeroflot (the Soviet civil aviation organisation) and the Concorde of Air France, British Airways and probably many other airlines. These new routes have been planned to avoid making supersonic bangs over populated areas. Many countries forbid supersonic bangs over their territory, so supersonic airliners have to slow down to subsonic speed to cross



On a flag-waving whistle-stop tour the Concorde showed off its grace and pace in the Persian Gulf states, calling in at Dubai (above), at Kuwait (below, left) and Doha, capital of Qatar (below, right).

them, or else fly round them. This has affected the planning of supersonic routes.

Wherever possible they are routed across the oceans. London to New York starts off subsonic, leaving Heathrow Airport by way of Woodley (near Reading) and then, instead of following the usual airway route over Brecon, in Wales, it passes over Bristol. This brings Concorde over the wide Bristol Channel, where it can accelerate to its cruising speed of about Mach 2.09 (nearly three times the speed of sound). It keeps at full speed, missing the southern tip of Ireland, until it is within a few minutes of its destination.

Flying at full speed all the way, more than ten miles high, is just what Concorde passengers like. They get to their destinations in less than half the time.

To show this really is so, on Monday, June 17, an Air France Concorde took off with a full load of passengers from the American city of Boston. It flew to Paris in three hours nine minutes. On the way it passed an Air France Boeing 747 Jumbo, the fastest airliner at present in service anywhere, which had left Paris just as the Concorde left Boston. The Concorde landed at the new Charles de Gaulle airport and spent a full hour on the ground, being readied for a new passenger load. Then it took off and flew back to Boston. Nearing Boston it passed the 747, and landed ten minutes ahead of it!

Even if it has to fly subsonically, Concorde's cruising Mach number of 0.93 means it goes much faster than other airliners.

A few weeks ago *SPEED & POWER* flew in G-BBDG, a pro-

duction Concorde in the new British Airways markings. The fantastic journey was from London to Tehran, the capital of Iran. Most of the 2,500 nautical mile (2,880 miles) trip had to be flown at only Mach 0.93, across Europe. Then we accelerated to Mach 2.09 for the last bit and still arrived in half the seven hours taken by ordinary airliners!

Another series of flights made earlier in 1974 was between Paris and Rio de Janeiro, Brazil. This is a very long journey, and it cannot be flown by today's airliners in less than 11 hours 55 minutes. It was thought Concorde could do it in 6 hours 45 minutes, but this was a great over-estimate. Concorde F-WTSA made the trip ten times, and each journey took just over six hours. On June 5 it did the complete round trip, from Paris to Rio and back, in daylight!

By now, everyone knows what Concorde looks like. Its shape is so familiar that it is easy to overlook the fact that the production Concorde is quite a lot different from the original prototypes, and those historic aircraft were quite different from the original project of November 1962.

## SMALL CONCORDE?

When Britain and France decided to work together to build Concorde they at first thought of it as a quite small aircraft, carrying about only 90 passengers. France decided to build a short-range version and Britain a long-range

**CONTINUED ON NEXT PAGE**







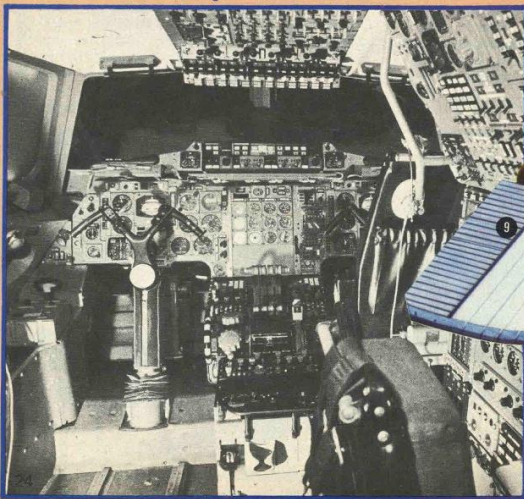
## Record-Smashing CONCORDE

one. But the major airlines showed no interest in a short-range airliner, because the main route for a supersonic was obviously going to be the long hop across the North Atlantic. This meant a bigger Concorde, with bigger engines.

Fuel tanks were put in under the floor and baggage had to be moved to the tail end. This meant there could not be a stairway at the rear, so a second passenger door had to be put in on the left side. Having decided all this, construction began on two prototypes, 001 and 002, in April 1965.

The first prototype Concorde flew from the base of Aerospatiale, the French airframe builder, at Toulouse on March 2, 1969. The pilot was Andre Turcat. The second flew from Filton, Bristol, where it had been assembled by British Aircraft Corporation, on April 9, 1969, in the hands of Brian Trubshaw. (These two chief test pilots were featured in *SPEED & POWER* No.4.)

A mock-up of the flight deck was used to plan the positioning of the Concorde's controls, using real flight equipment and instruments. One pilot seat and the engineer's seat is shown.



The airlines kept wanting even more, so the next two Concorde were rather different. Passenger capacity was increased to 130 by making the forward fuselage longer, and extending the cabin much further back towards the tail. The nose was made quite a different shape, with a nice-looking transparent visor instead of the metal one used previously. The wing leading edges and tips were curved in subtle ways to make the wing give more lift and less drag. New engines were installed, with a low-pressure fuel system that was lighter and worked better, and a redesigned annular combustion chamber with vaporising burners that completely eliminated the sooty smoke that had been so visible with the first Concorde to fly.

Aircraft 01, the first of these pre-production machines, flew at

Filton on December 17, 1971. It was followed by 02 at Toulouse on January 10, 1973. In 02 there were two further big changes. The tail end of the fuselage was made much longer and swept upwards to give less drag and more fuel capacity (and it looks better too). The four engine nozzles were completely redesigned, with upper and lower hinged flaps serving as the control for the variable area, to match the engines to different flight conditions, and as the thrust reversers.

The latest production versions of the aircraft have several detail changes, including a smooth, transparent nose visor instead of a metal one.

At the Farnborough Air Show this year, a pre-production Concorde (02) put on a daily display of flying and touch-and-go on the runway for the benefit of the many foreign visitors. 02 was the aircraft which first flew from Toulouse on January 10, 1973.

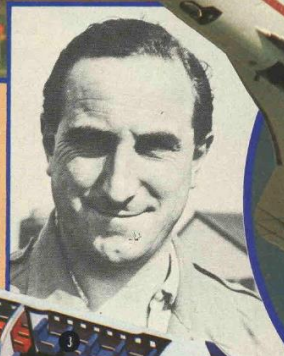


By mid-1973 these four Concorde had flown 2,000 hours. The tremendous Concorde had set an amazing standard of reliability which had deeply impressed everyone who had come into contact with it. In between development flying from Toulouse and Fairford (the BAC test base in Gloucestershire) flights had been made to all parts of the world.

Fourteen more Concorde are on the assembly lines.

A further example of how Concorde can cut down route times was made during the Farnborough air show. On Tuesday, September 3, it clipped the best subsonic time from Bahrain to Singapore from 7 hours, 50 minutes to just 3 hours, 38 minutes. The maximum height reached was 59,000 feet and for more than half the flying time Concorde was supersonic, reaching a top speed of Mach 2.09.

A fine shot of the underside of 02 showing the two pods housing the four engines. Left: Brian Trubshaw who carried out exhaustive test flying of the Concorde prototypes.



A pre-production Concorde. (1) Nose housing radar. (2) Galley. (3) First Class cabin. (4) Tourist Class. (5) Passenger entry door. (6) Radio aerials. (7) Main undercarriage. (8) Olympus turbojets by Rolls-Royce. (9) Ailerons. (10) Baggage stowage. (11) Tailplane. (12) Rudder.

Photos: British Aircraft Corporation/D. Windsor/L. Hammond



# Speed & Power

**FIRST PLANES  
ROUND THE  
WORLD**



**Great Inside Story**



**FANTASTIC FERRARI**

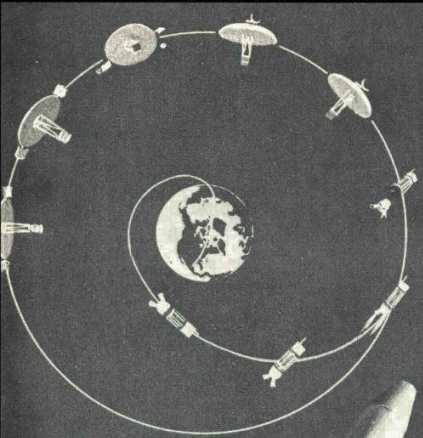
**SHIPS SPACE TRAINS  
PLANES CARS**

**JUMP TO IT,  
SOLDIER!**

**SCIENCE FICTION**

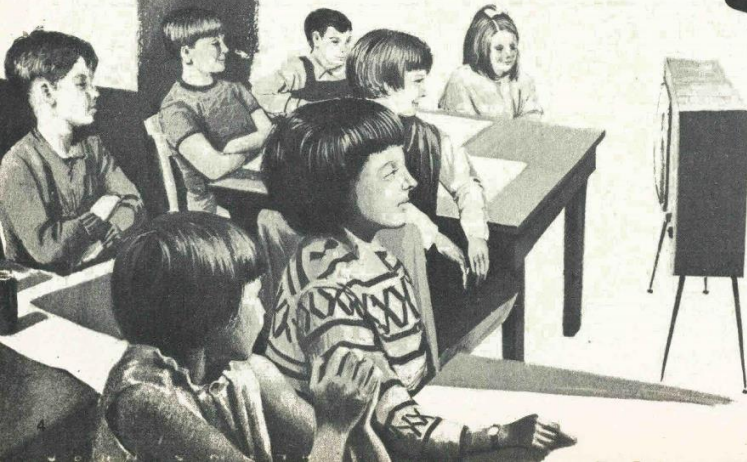




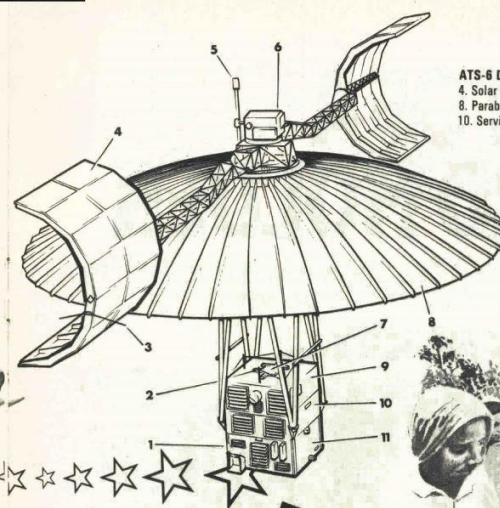


Above: The orbit of the ATS-6 around the Earth. The satellite is shot into space with its reflector antenna and solar panels folded up. These extend as the machine starts its journey round the Earth. Right: Titan III-C takes the teaching satellite into space.

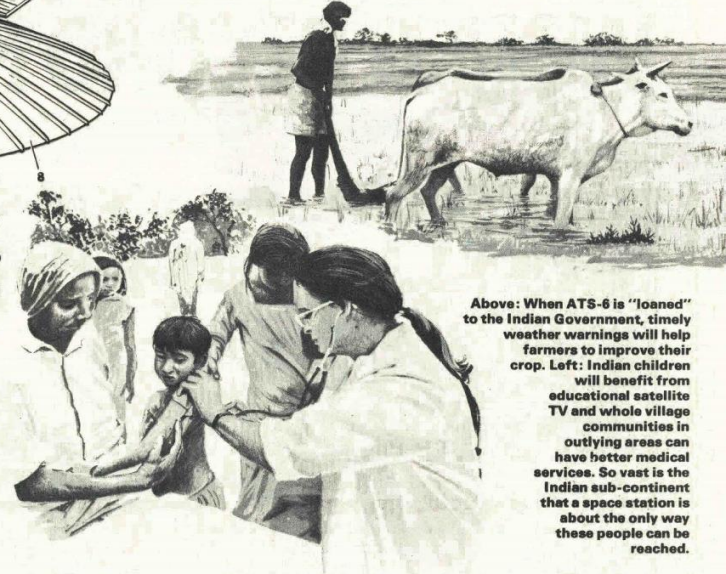
Right: How the ATS-6 unfolds in space orbit. The solar panels extend to span 16.5 metres and 21,000 cells pick up the sun's light. Below right: Fully open, ATS-6 looks like this.



When they went back to school this autumn, thousands of American children found they had a new robot teacher—a satellite orbiting the Earth more than 22,000 miles out in space. Their lessons come from ATS-6 (sometimes referred to as ATS-F), the latest Applications Technology Satellite.



ATS-6 DRAWING KEY: 1. Earth viewing module 2. Reflector support 3. VHF antenna 4. Solar panel 5. Magnetometer 6. Environmental measurement experiments 7. Prime focus feed 8. Parabolic reflector antenna 9. Communications module 10. Service module 11. Experiments module



Above: When ATS-6 is "loaned" to the Indian Government, timely weather warnings will help farmers to improve their crop. Left: Indian children will benefit from educational satellite TV and whole village communities in outlying areas can have better medical services. So vast is the Indian sub-continent that a space station is about the only way these people can be reached.

# THE PEOPLE'S SATELLITE

In the next year or so ATS-6 will show whether such satellites could be used on a large scale to help raise living standards and improve education in different parts of the world.

In addition to its teaching role, ATS-6 can be used to transmit to community receivers information on farming techniques, irrigation, hygiene, child care, nutrition, food preservation and many other subjects that would be of interest and value to developing nations.

One of its first tasks was to transmit seminars for teachers in rural areas of America, to enable them to keep abreast of new educational techniques. It is also being used for two-way medical consultations between doctors in outlying districts of Alaska and specialists in medical centres in other parts of the United States.

## MORE SATELLITES

If its services are found to be useful, similar satellites will undoubtedly be used in the future to put the benefits of modern technology within the reach of more people.

ATS-6 operates in what is called a geosynchronous orbit, 22,300 miles above the equator. In this position it matches exactly the Earth's rotational period, and so remains over a fixed point.

At present it is positioned at 94 degrees west longitude over the equator, where it has a view of the entire continental United States.

After a year's trial by rural communities in America it will be moved eastward to another point over the equator and loaned to the government of India for a year. Its main task there will be to transmit educational television programmes to about 5,000 isolated villages in the northern part of the sub-continent. TV receivers are already being installed for the programmes, which the Indian government will provide.

When the Indian experiment is over, the craft's manoeuvring motors will again be ignited and the satellite pushed back to its former location. It is then expected to give at least three more years service before the fuel needed to keep it in position runs out.

ATS-6 is by far the biggest and most powerful communications satellite ever launched. It stands 27 feet high and has an umbrella-like antenna which is 30 feet in diameter. The electricity it needs comes mainly from sunlight, gathered by more than 21,000 solar panels. Its power—200,000 watts—is more than 30 times that of any previous communications satellite, and its transmissions to Earth are beamed with great accuracy.

This means that the large and costly receiving antennas and the highly-skilled technicians needed to gather signals from other communications satellites can be dispensed with. Simple, do-it-yourself antennas, built and assembled in a few days, will pick up the powerful signals from the people's satellite. And this in turn means that any suitably-located school, hospital or village community can gain direct access to the satellite with very little expense or effort.

## SELF-PORTRAIT

If all this were not enough, ATS-6 also carries about 20 scientific experiments, including such things as position-locating and navigating equipment to help ships and aircraft on the busy North Atlantic sea and air lanes, and a radiometer for accurate predictions of the arrival of the monsoon in different parts of India.

Shortly after it was launched at the end of May this year, ATS-6 was guided by radio signals from Earth through a series of complicated manoeuvres to its present position. Then the craft was ordered to send back a photograph of its big antenna, so that engineers could check whether it was in its correct operating condition. This was probably the first self-portrait of a spacecraft in Earth orbit.



Last week we saw how navigating equipment on board ships is becoming more and more advanced. What of the future? Is it possible that there will be ships in control themselves, without crews? Such ships are more than a dream...

# SHIPS WITHOUT SAILORS

Above: Sitting in the comfort of a land-based control centre, one man could monitor and direct several robot ships. Radio communication would be received at the control centre (right) via satellite. Once underway, the ships would be mainly automatic but the "captain" on land would have over-riding control, by radio, in an emergency.

THE giant cargo ship heads out of port, carefully navigating around rocks and deadly reefs, heading for deep water. It continues into a busy shipping lane, where collisions between ships are not unknown, and safely carries on its journey to a port on the other side of the world. This may seem like an every-day account of a ship's journey, but there is one difference.

This ship has *no crew!* Unmanned ships may well become reality in the future. And why not? After all, men sitting at desks in Houston, Texas, can take over the direction of a space vehicle on its way to the Moon!

Many ships already have equipment which monitors temperatures and controls the flow of fuel and lubrication. They switch over to an automatic helmsman as soon as they get out on the high seas. On some ships, navigational functions are performed automatically

by onboard computers which gather data from satellite and other anti-collision radar navigation receivers, and other equipment on board. The results of all this information are presented to the captain and his officers, who take action accordingly.

The same data, perhaps backed up by TV pictures, could just as well be sent by automatic error-correcting radio equipment, already in use on oil rigs as well as on some ships, and passed on to the shore computer by the radio receiver. The computer would assess the information in a flash and present a continuously updated summary of the ship's workings and its situation to the "captain" sitting at his desk. The computer would itself be able to "command" the ship, to change its course or speed, for instance, by radioing instructions to the main "automator" on board. But the shore-based captain would have overriding control, also by radio, in an emergency. Radio contact between the ship and shore could well be via a communications satellite.

All this, of course, assumes that there wouldn't be many other ships about, such as when the ship is on ocean passage. But what happens when the unmanned ship comes into coastal waters with heavy ship traffic? Other electronic aids would then be switched into circuit—an echo sounder checking the depth of water, navigational radar and an automatic direction-finder taking bearings and ranges on coastal features and radio beacons.

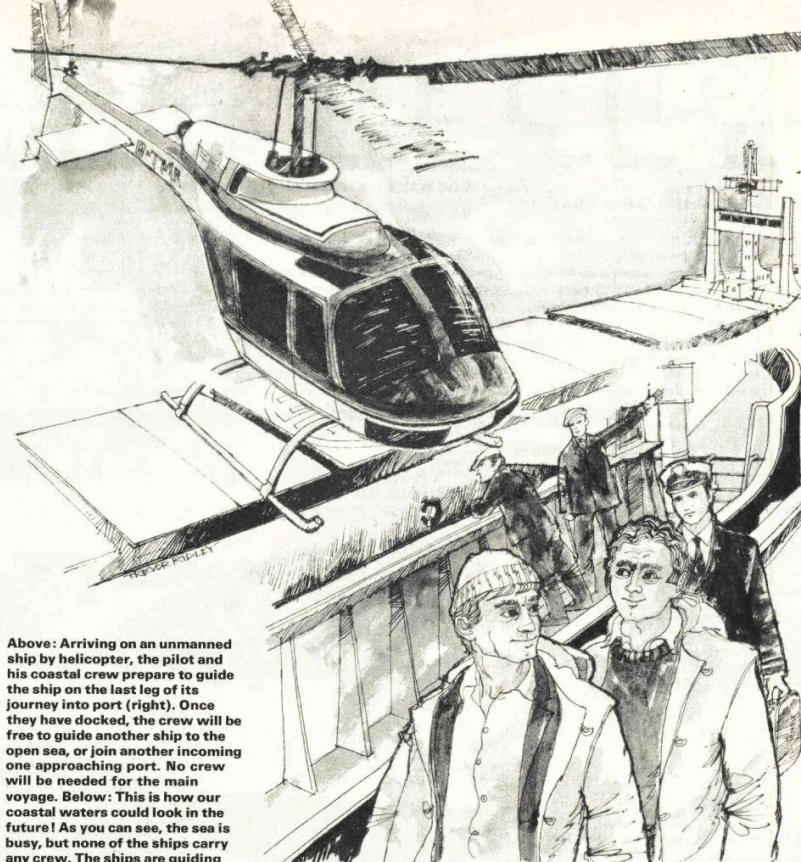
There could also be sonar searching ahead of the ship for underwater obstacles. Then, on still closer approach to the destination port and entry into a heavy traffic area, control would have to be handed over to humans again. For this, a helicopter would land a pilot and his small crew to bring the ship safely through narrow and busy channels to the dock.

## REMOTE CONTROL

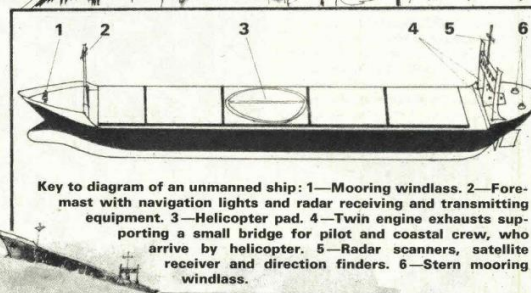
Once cargo loading and discharging had been completed the same crew could then take the ship out again until she was in open waters, where they would switch her over to remote control and take off in their helicopter.

So, only one small crew at each terminal port could handle a number of incoming and outgoing ships without ever having to go more than a short distance out to sea. At present, crew wages, food, accommodation and amenities and services make up a fair slice of a ship's operating costs. An automatic ship would have no crew costs.

A study is now underway in the United States, and experiments could soon begin on the sea, using ships controlled by land-based computers. The day may not be far away when the sea lanes are busy with ships without a single soul on board...



Above: Arriving on an unmanned ship by helicopter, the pilot and his coastal crew prepare to guide the ship on the last leg of its journey into port (right). Once they have docked, the crew will be free to guide another ship to the open sea, or join another incoming one approaching port. No crew will be needed for the main voyage. Below: This is how our coastal waters could look in the future! As you can see, the sea is busy, but none of the ships carry any crew. The ships are guiding themselves—helped by men in a land-based control centre!



Key to diagram of an unmanned ship: 1—Mooring windlass. 2—Foremast with navigation lights and radar receiving and transmitting equipment. 3—Helicopter pad. 4—Twin engine exhausts supporting a small bridge for pilot and coastal crew, who arrive by helicopter. 5—Radar scanners, satellite receiver and direction finders. 6—Stern mooring windlass.



# SUPER TRAMS

by A. Winstan Bond

**W**ORK has started at Newcastle-on-Tyne on a completely new form of urban railway. By 1979 there will be a 34-mile rapid transit system, and it will have been built at a fraction of the cost of a traditional underground railway. If Tyneside is successful we may soon see similar systems in other large

cities such as Leeds, Glasgow, Liverpool and Birmingham.

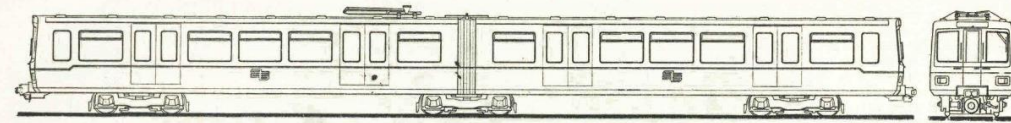
As road congestion has increased its stranglehold on city life, people in North America and Western Europe are moving away from building yet more and more roads and car parks. Instead, vast sums are being allocated to provide high speed urban railways.

However, there are so many cities wanting rapid transit, as the new systems are called, that if they all had to be built to the specification of London's Underground the money would just not be available. Fortunately there is a solution.

Where the passengers to be carried are 40,000 per hour then a

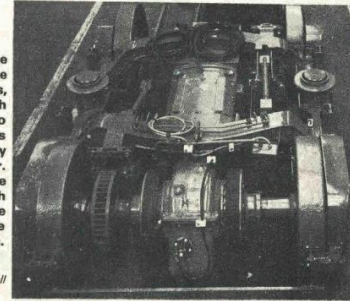
heavy underground type line is indeed the only solution. But, where the traffic is between 15,000 and 30,000 passengers per hour, light rapid transit could do the work efficiently and at a low cost.

Light rapid transport technology and operating procedures are based on modern Continental tramway systems. It involves high



Above: There will be over 100 trains built for the super tram system, each seating 84 people and controlled by one operator. The lightweight units will be coupled together at busy times. The first ones should be ready for testing next year.

Right: One of the new bogies to be used in the trains, which will each consist of two coaches permanently coupled together. Each will have three bogies, with the middle one supporting the coupled ends.



Photos: Metro-Cammell

performance "super trams", which are cheap to maintain and need only one operator. Ideally the tracks are completely separated from other traffic, and like any tramway, run with little signalling.

Stopping places are also simple and without station staff. Tickets are sold from automatic machines and cancelled by the passenger in another machine on the tram. This form of transport can be built at a price most cities can afford.

During the last fifteen years the Germans have gradually upgraded

their street tramways, putting them on to reserved tracks, in shallow tunnels, or down pedestrian precincts. This has proved to be a very economical way of introducing rapid transit on a large scale.

In this country only Blackpool and the Isle of Man now have tramway systems, so the introduction of light rapid transit is made much more difficult and expensive for us.

The solution adopted at Tyneside is to re-equip sections of the

suburban railways to form most of the system, linking the sections with a tunnel in the city centre. The tunnels are estimated to cost £30 millions—nearly half the entire cost of the project for just 6.7 miles!

British Rail will still want to use a few sections for freight tracks, so there are some signalling problems. The intention is to have two-colour signals working off track circuits with the addition of automatic train stop equipment in the underground section.

## GIANT BRIDGE

Tyneside was lucky in that there were railway tracks available in most of the right locations. It does however have a special problem. The River Tyne cuts the system in two, necessitating a bridge, the sixth in the area. The design is for a steel truss bridge with an overall length of 1,154ft. and a height of 82ft. The centre span will be 500ft. long and the bridge will cost £1.7 millions.

As the system is all on private right of way, third rail current collection could have been used. The through running of British Rail

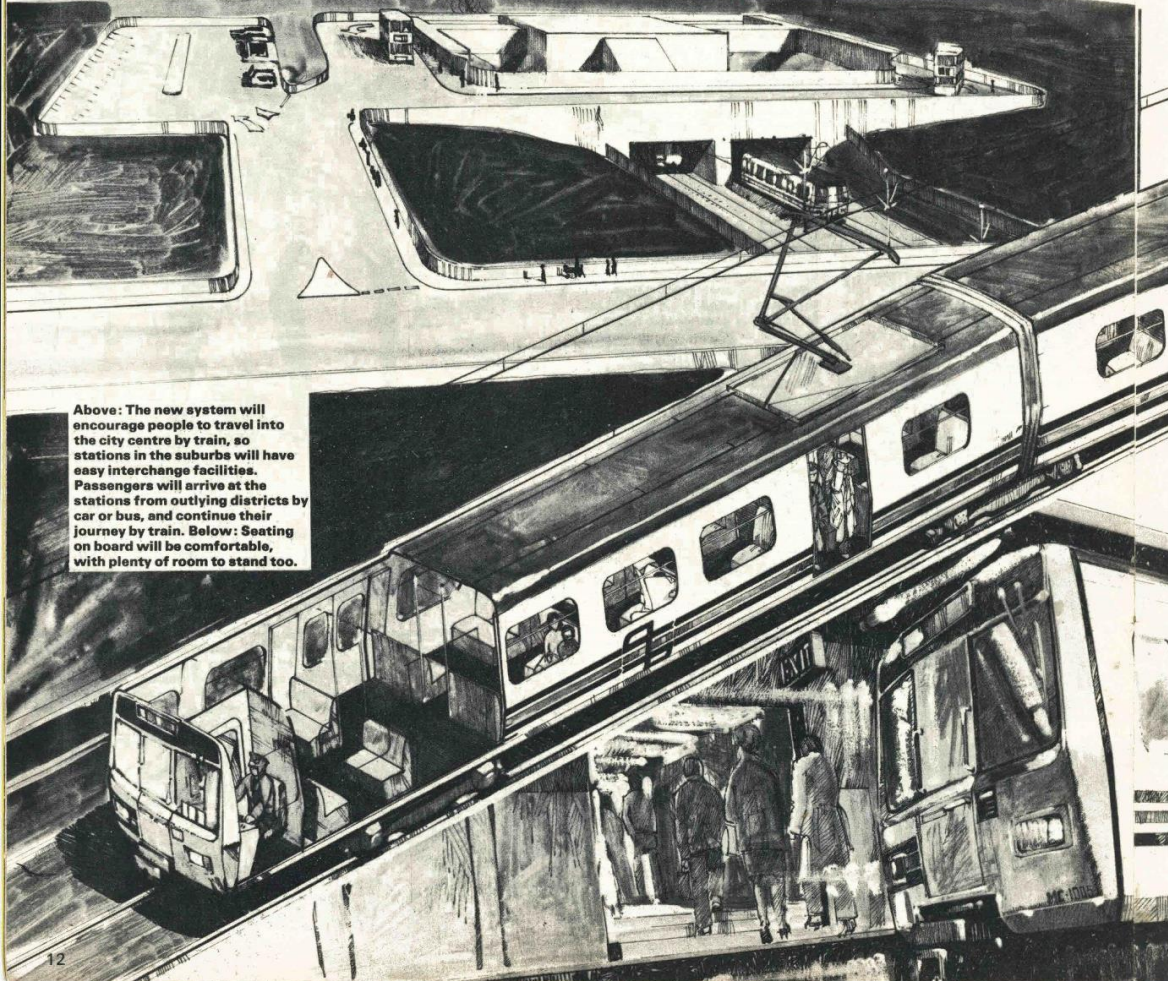
freight on some sections has however meant that overhead collection will be used for the current of 1,500 volts D/C.

Two prototype supertrams are now being built at Metro-Cammell in Birmingham. The most striking feature is the ball bearing ring articulation in the centre, which is supported on an unmotored bogie. These features, and the double ended motors on each outer bogie are of German design. Acceleration is rapid and they have a top speed of 50mph (80km/h).

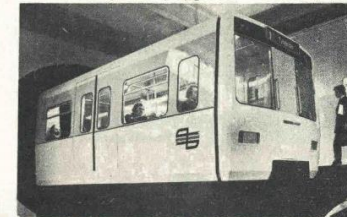
Emergency stops are made by magnetic track brakes fitted to all three bogies, while the more gentle service stops are a combination of disc and electronic braking. The body is a welded steel frame clad in aluminium with reinforced glass fibre ends.

Because the line incorporates a tunnel there are doors in the ends to let the passengers out in case of an emergency. Fully loaded, the "super trams" will carry 84 seated passengers, and 188 standing, making a total of 272 per unit. They are designed for multiple unit operation of up to three units. So just one operator can speed over 800 people to and from work.

Below: Before the end of this decade, the Tyne and Wear Metro, as it will be called, will be whisking passengers across Newcastle. It will use tracks previously used by ordinary trains, and busy scenes like this will be regularly seen.



Above: The new system will encourage people to travel into the city centre by train, so stations in the suburbs will have easy interchange facilities. Passengers will arrive at the stations from outlying districts by car or bus, and continue their journey by train. Below: Seating on board will be comfortable, with plenty of room to stand too.



Left: This mock-up, built by Metro-Cammell, gives a good idea of what the new 1,500 volt electric trains will look like.



10p Weekly No. 39 December 13-20, 1974

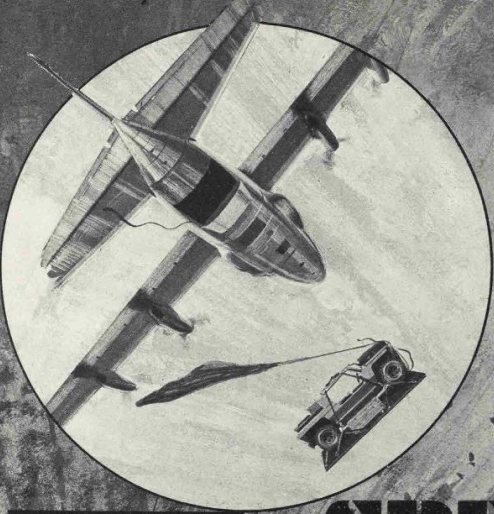
# Speed & Power

**SPACE  
SHIPS CARS  
SCIENCE FICTION**

**HARRIERS  
IN THE  
MARINES!**

**DESERT  
EXPRESS**





The "Speedy Jeep" weighs only 2½ tons and is easily air-portable. It can be dropped in battle zones, civil trouble spots or remote areas for reconnaissance.

THE XR-311 armed "jeep" crept up to the top of the hill and stopped. The radio operator leapt from his seat and crawled to the brow of the hill. In the valley below he could see a score of enemy tanks and armoured personnel carriers, led by an advance guard of two light tanks.

A quick radio call to headquarters established that there were no friendly units in the area. It was up to the crew of the jeep to delay the enemy until help arrived.

The XR-311 quickly sped down the hill and took up position behind some bushes 1,500 yards from the brow. The gunner loaded the TOW launcher with a complete round. In a few minutes the two light tanks appeared over the top of the hill and started down the hill. The gunner swung his TOW launcher towards the lead tank, aligned the gunsight crosshairs

and fired the missile. Within seconds the first of the two tanks was a flaming wreck. The second tank increased speed and its gun started to swing towards the XR-311. But before it was able to fire, the jeep gunner had loaded another missile and fired again, leaving the enemy tank a mass of twisted metal.

### QUICK GETAWAY

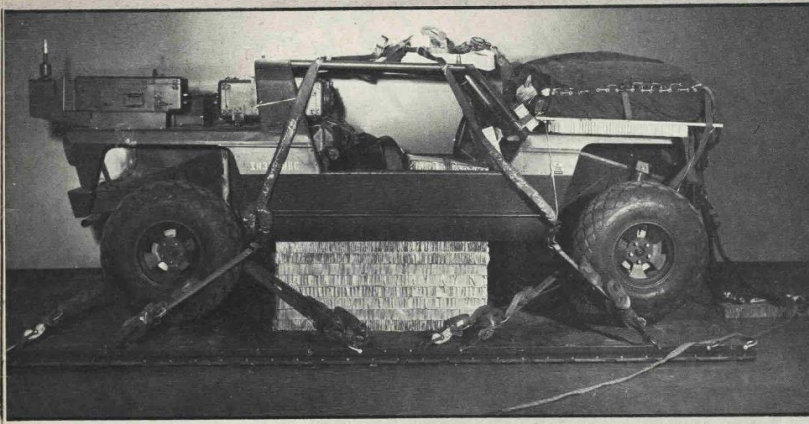
Speeding back down the road at nearly 80mph, the "jeep" took up another position, so that it could fire again when the rest of the enemy force appeared. But as the gunner prepared for another action, reinforcements arrived, relieving the XR-311 of its task so it could return once again to carry out its main role—reconnaissance.

This "Speedy Jeep" has been developed by the FMC Corporation of San Jose, California, who make the famous M-113 Armoured Per-

# SPEEDY JEEP



The XR-311 skids to a halt and the driver leaps forward to help the gunner open fire on enemy tanks with the TOW missile launcher. The main task of the "Speedy Jeep" and its crew is armed reconnaissance, but it can also play a role as a highly mobile "hit-and-run" unit.



Above: For airdrops the XR-311 is strapped to a special pallet and supported on the underside by a stack of crushable material that will absorb the shock of the parachute landing. The packed parachute can be seen on the front of the jeep, with the static clip-on release line in the foreground. Centre, below: The Command vehicle version with the soft hood raised. Automatic transmission and four-wheel drive are standard. Bottom: The TOW anti-tank missile version, with spare missile rounds carried in the containers on the flat rear deck. When fired, the missile trails a thin wire along which signals are transmitted by the gunner to correct its flight.



sonnel Carrier and the Super Hog LVT-7 vehicles. Development started in 1970 as a private venture and two prototypes were built. These were tested all over the United States and great interest was shown in the vehicle.

In 1971 the American Army ordered ten of them for trials and these have now been delivered. Of these vehicles, four were fitted with the TOW (Tracking Optical Wireguide) anti-tank missile system, three reconnaissance vehicles with 12.7mm machine guns and three escort/security vehicles with attached armour and a 7.62mm machine gun. In addition a wide range of other kits have been developed enabling the vehicle to be used for police roles, as a riot control vehicle, mortar vehicle and a medical evacuation vehicle.

### 4-WHEEL DRIVE

The XR-311 features permanent 4-wheel drive (all four wheels are driven all of the time), and is powered by a Chrysler V8 petrol engine that develops 187 brake horsepower. This gives the vehicle a top road speed of 80mph, and a range of 300 to 400 miles. It will accelerate from 0 to 60mph in 12 seconds, which is twice as fast as a standard Mini car!

It has excellent cross-country mobility thanks to its independent suspension and large tyres. These have two inner tubes so if one is punctured the vehicle can continue to fight. It can climb a gradient of 60 per cent, (a hill rising up 6 feet for every 10 feet forward), ford water 30 inches deep and climb a step 20 inches high.

Automatic transmission is fitted as standard, and so is powered steering. If required, a winch with a pull capacity of 11,000lbs (about 5 tons) can be fitted at the front of the vehicle so the jeep can pull itself out of most trouble.



# RESCUE under the sea

**I**TS LIGHTS reflecting strange rock formations, weed and shoals of tiny phosphorescent fish, the mini-submarine homes in on its target. But this is no war cruise. Our tiny sub is on a rescue mission to save the crew of a damaged full-size submarine lying on the sea bed.

Known as Underwater Rescue Vessel (URV), such a craft is being studied by the Royal Swedish Navy. It will be the first of its kind when it goes into service about 1977.

Civil uses are also foreseen for the URV, especially in the North Sea, as the search for gas and oil hots up.

This type of vessel doesn't have to be fast—the Swedish URV does a maximum of only 3mph—as its job is to make a thorough search of any areas where a sub may be trapped. To do this properly, a URV must be able to withstand the immense pressures deep under the sea. The new vessel is made of a special new high tensile steel which will enable it to

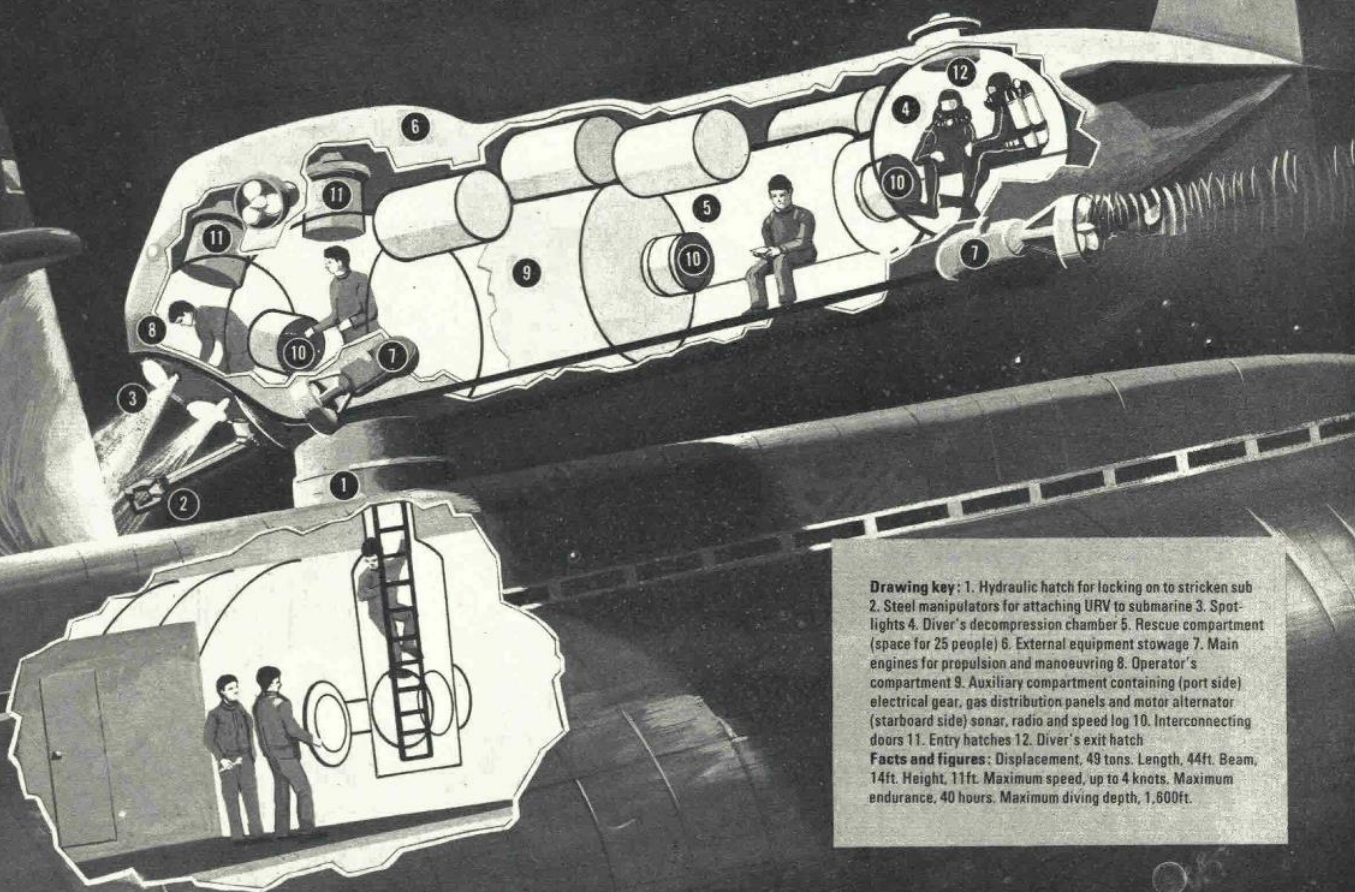
dive to 1,600ft., far below the maximum depths of most North Sea areas.

The URV can search for only ten hours, so it is towed to the rescue area and released, travelling only a short distance under its own power.

Sonar and the acoustic signals from the stricken craft help the URV to "home" on to the target. Metal manipulators then lock the mini sub to the hull.

If the rescue takes time, the URV is designed to stay on station for up to 40 hours, using an air cleaning system.

A crew of five is carried by the URV—two pilots, an engineer and two divers—but up to 25 men can be transported. Several URVs could be used to rescue the entire crew of a stricken submarine.



**Drawing key:** 1. Hydraulic hatch for locking on to stricken sub 2. Steel manipulators for attaching URV to submarine 3. Spotlights 4. Diver's decompression chamber 5. Rescue compartment (space for 25 people) 6. External equipment stowage 7. Main engines for propulsion and manoeuvring 8. Operator's compartment 9. Auxiliary compartment containing (port side) electrical gear, gas distribution panels and motor alternator (starboard side) sonar, radio and speed log 10. Interconnecting doors 11. Entry hatches 12. Diver's exit hatch

**Facts and figures:** Displacement, 49 tons. Length, 44ft. Beam, 14ft. Height, 11ft. Maximum speed, up to 4 knots. Maximum endurance, 40 hours. Maximum diving depth, 1,600ft.



Low, sleek and with every imaginable "extra" fitted, the MPO Transcontinental long distance off-the-road cab could be the desert driver's dream come true

LOOKING like a futuristic vehicle from the famous *Thunderbirds* TV series, this exciting MPO Transcontinental commercial vehicle cab was designed and engineered by Motor Panels (Coventry) Ltd., the largest independent producers of truck cabs in Europe, and the interior styled by the Ogile Design Group.

Using basic body panels from the Motor Panels production line, the exterior and interior of the cab have been trimmed by Ogile to produce an Off-Highway vehicle that would be suitable for military, oilfield, civil engineering and aviation in a variety of tasks where a good off-the-road capability was desirable.

The most obvious features of the MPO cab is the central driving position with the four crew seats behind it. The cab also has a low profile with a long overhang at the front giving good visibility through the well-curved windscreen.

This particular version was designed for operation in hot climates. The radiator air duct, engine air intake and air conditioning plant are all roof mounted so as little dust as possible is picked up when following other vehicles. The cab is fitted with "Sundym" glass to reduce glare and the windscreen is swept by triple wipers. Door windows are electrically operated by the driver or by the crew. Special lighting equipment is fitted into the bumpers and the main headlamps are cleaned by six mini-wiper/washer units. The wing mirrors are electrically heated for de-misting and de-icing.

The central driving position features a revolutionary Dunlop air suspension seat which provides a constant standard of ride comfort and automatically compensates for drivers of varying weights.

Driving controls are grouped around the driver in "aircraft cockpit" style. The instruments include a rev counter, a tachograph which automatically records time, distance, stops, and so on throughout the journey, and a gimbal compass. Extra refinements include a radio-telephone for mobile-to-base communication, an automatic route finder that traces the vehicle's progress on a map of the area it is travelling through (in desert regions, where landmarks are few,

this device would be invaluable), a wash basin with running water, a refrigerator for crew snacks and cold drinks, first aid boxes and fire extinguishers.

Spring-loaded sun blinds shield the inside of the cab and the crew's comforts are catered for by a cigar lighter, stereo radio/cassette player and vacuum flasks.

Although the MPO is not at present a working vehicle, a likely power unit would be a 280bhp diesel engine driving through an automatic gearbox.

#### KEY

- (1) Guides for sun blinds
- (2) Electrically-heated mirrors
- (3) Automatic route finder
- (4) Stereo radio/cassette player/radio-telephone
- (5) Compass
- (6) First aid
- (7) Fire extinguishers
- (8) Removable bags for crew's personal effects
- (9) Constant-ride comfort driving seat
- (10) Electric windows
- (11) Air conditioning
- (12) Crew seats and control console



# DESERT



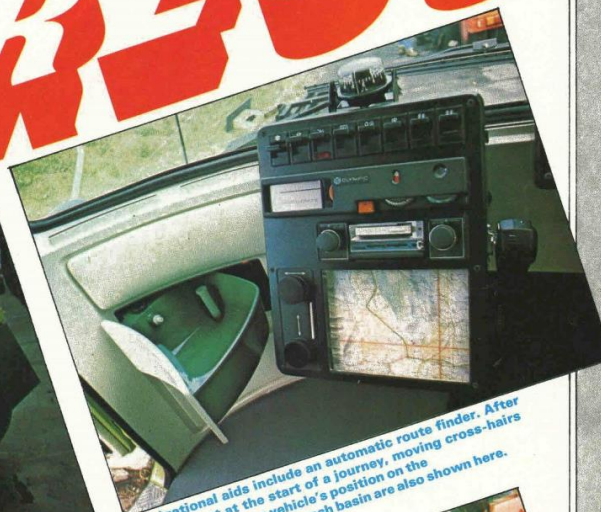
Photos courtesy Motor Panels (Coventry) Ltd.



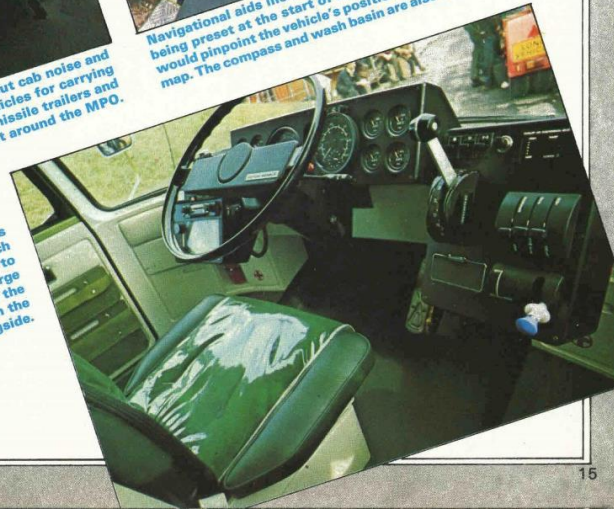
The exterior of the MPO cab sports triple windscreen wipers for the Sundym glass, six mini-wiper/washer units for the main headlamps, electrically-heated wing mirrors for de-misting, flick-back radio aerials and roof-mounted air intakes.



The rear-mounted engine position would cut cab noise and heat to a minimum. A variety of vehicles for carrying heavy plant, freight, military, missile trailers and oilfield equipment could be built around the MPO.



Navigational aids include an automatic route finder. After being preset at the start of a journey, moving cross-hairs would pinpoint the vehicle's position on the map. The compass and wash basin are also shown here.



The central driving position is fitted with a seat which automatically adjusts the ride to a driver's weight. The large lever by the steering wheel is the auto-gear change with the heater controls alongside.





Above: An artist's impression of a jet train terminal, showing passenger boarding gates and engineers servicing the train before its journey of up to 500 miles. Below: Inside, passengers would be seated in aircraft-type luxury, with air-conditioning and soundproofing.

Below: A jet train of the future literally "flies" along a main line at over 300mph. The drawing incorporates all the main features that Ford will use in their prototypes now being designed in the USA.

FLY BY RAIL

# JET

IN TOMORROW'S

# TRAINS

The trains of tomorrow may well take off and fly if this new system is developed. Then speeds three times as fast as today's trains could be possible.

PASSENGERS travelling on Route 213 to Detroit, please proceed to the boarding gate," echoes the loudspeaker system in the large terminal. You go to the gate as instructed, board, and fasten the seat belt. Dead on departure time, you move off. As speed picks up, the undercarriage retracts and you are "flying" along at over 300mph, with no sound

but the hum of the air-conditioning system. This is not an airliner as you might have imagined, but a train flying above a railway! But trains can't fly, you will say. Well, they certainly will if a system now being developed by the Ford Motor Company is successful. Though only at the drawing board stage at present, the Ford

project is being financed by the United States Department of Transportation and prototypes will be put through their paces throughout next year.

The new trains will move at low speeds along a concrete and aluminium track on rubber-tyred wheels, but when they reach about 50mph they will "take off" and "fly" about one foot above the track. Guidance will then be by our old friend magnetic levitation.

This is the system that uses the principle that unlike poles of a magnet repel each other. In fact, a "magnetic field" will be created, supporting the train. A "ducted fan" at the rear of the train, sucking in air and forcing it out at a tremendous rate, will propel it along. Later on, a linear-induction

motor could be used instead. As you can see, the trains will be very much like jet aircraft without wings. The driver's cab will have sophisticated control and signalling equipment keeping trains a safe distance apart. The passenger compartment will seat about 150 people, all in aircraft-type luxury.

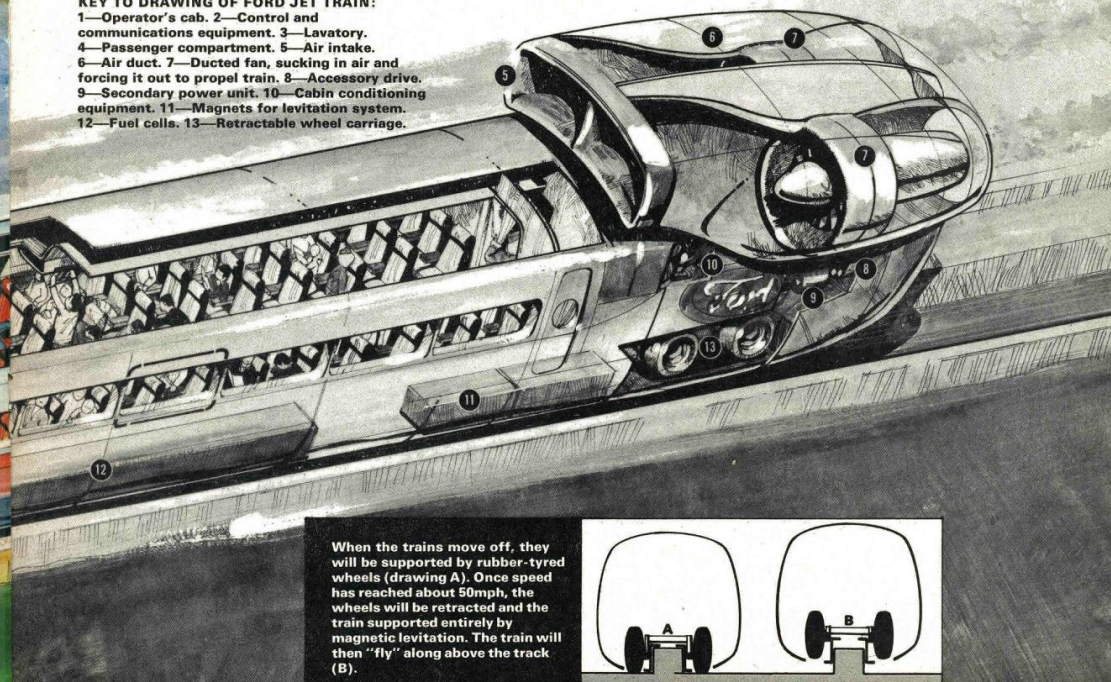
There is not much chance that we will see these trains in Britain, but in the USA—where distances are much greater—a fast and efficient rail system is essential. The Ford system would be ideal for distances of between 300 and 500 miles and "stations" could be placed at intermediate locations.

## FASTER SPEEDS

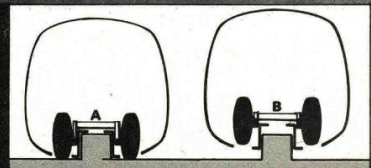
Ordinary rails limit trains to 200mph at the very most, due to friction and rail and wheel wear, but on this new system the trains won't even touch the guideway at speed, thus cutting out all wear and tear. This is what makes speeds of 300mph, and faster, possible. It may not be long before railway advertisements encourage people to "fly by rail"!

### KEY TO DRAWING OF FORD JET TRAIN:

- 1—Operator's cab. 2—Control and communications equipment. 3—Lavatory.
- 4—Passenger compartment. 5—Air intake.
- 6—Air duct. 7—Ducted fan, sucking in air and forcing it out to propel train. 8—Accessory drive.
- 9—Secondary power unit. 10—Cabin conditioning equipment. 11—Magnets for levitation system.
- 12—Fuel cells. 13—Retractable wheel carriage.

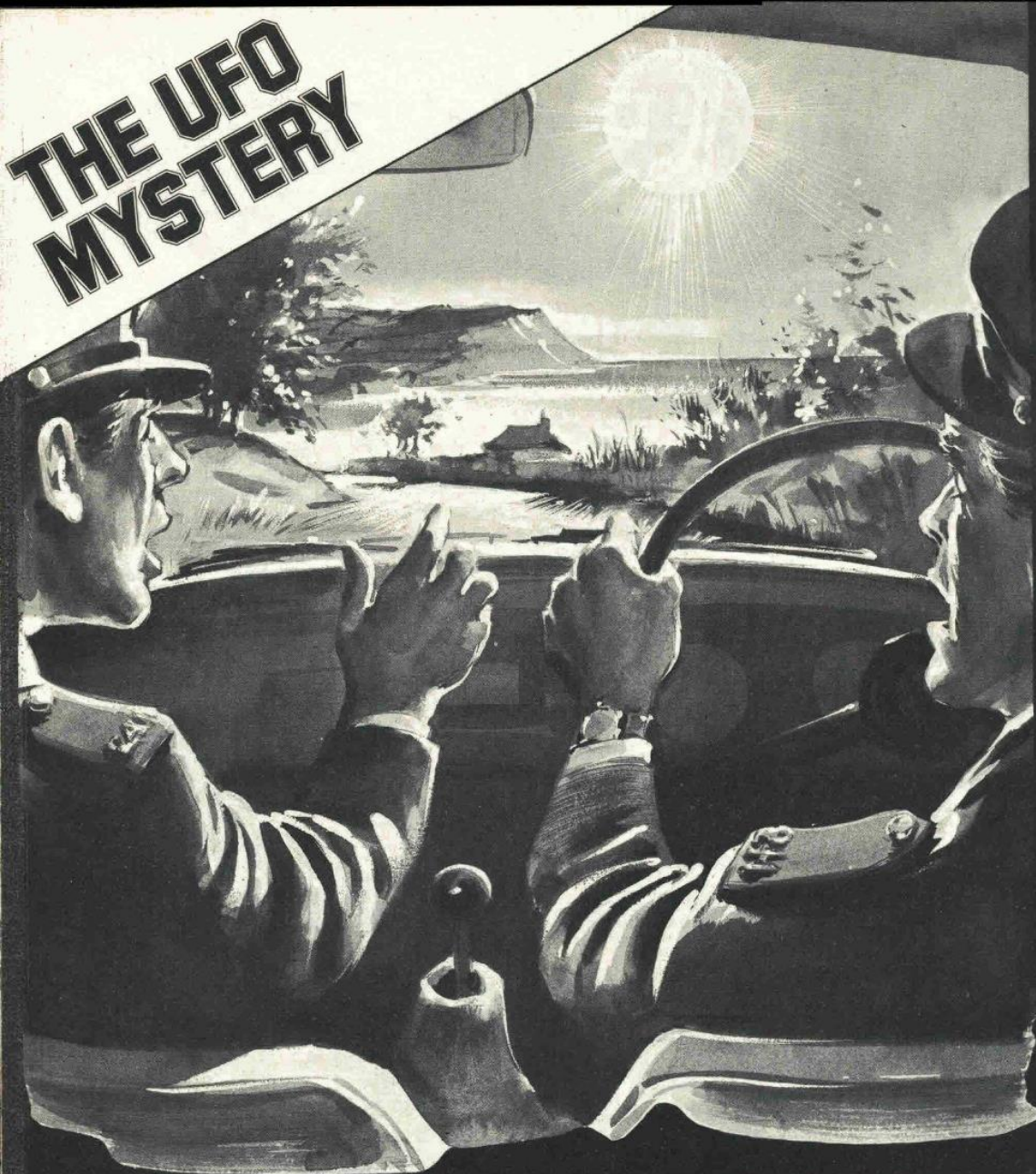


When the trains move off, they will be supported by rubber-tyred wheels (drawing A). Once speed has reached about 50mph, the wheels will be retracted and the train supported entirely by magnetic levitation. The train will then "fly" along above the track (B).





# THE UFO MYSTERY



**P**OLICE constables Clifford Waycott and Roger Willey could hardly believe their eyes as they drove along a quiet English road in Devon early one morning in October, 1967. Hovering just above them was a bright ball of light. They accelerated after it, but the "thing" must have seen them also for it, too, moved away and, even though at times the police car reached ninety miles an hour, they were unable to catch whatever it was.

It was later joined by a cross-shaped light, which was also extremely bright, before the two of them disappeared as mysteriously as they had come.

Soon afterwards some other policemen, in Derbyshire, saw a similar cross-shaped formation of lights in the sky. Many hundreds of similar occurrences were reported between October 25 and 27 that year.

## EXPLANATION

These phenomena "appeared" during a period when the US Air Force had been carrying out mid-air refuelling exercises and for a time this was accepted as a reasonable explanation for the sightings—until it was pointed out that the exercises had taken place between five pm and nine pm—but the lights had been seen between midnight and daybreak!

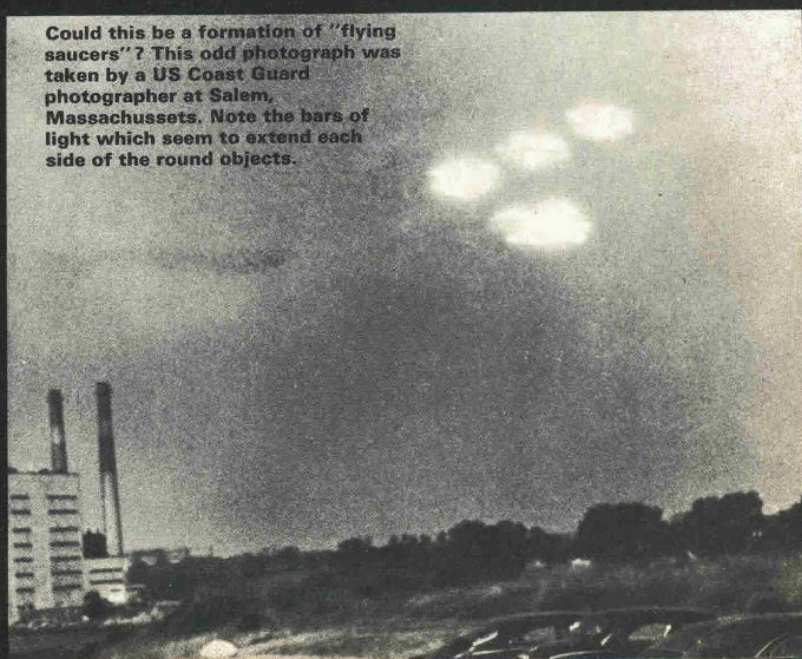
These sightings were not unusual, however. Reported sightings of "flying saucers", or UFOs (unidentified flying objects), have been common since the dawn of civilisation. Several references to what would today be classed as UFO sightings can be found in the Bible and other ancient works, but

**Left: Two Devon police constables chased "a bright ball of light" at up to 90 miles an hour, but couldn't catch it. It was later joined by another light, and both disappeared.**

# STRANGE LIGHTS IN THE SKY

Are we being watched from outer space? Many people claim to have seen "flying saucers", but are they all fakes? There's no real proof that they exist, but you never know...

Could this be a formation of "flying saucers"? This odd photograph was taken by a US Coast Guard photographer at Salem, Massachusetts. Note the bars of light which seem to extend each side of the round objects.





possibly the first book to be devoted solely to this subject was *Strange Signs from Heaven* which was published in 1646.

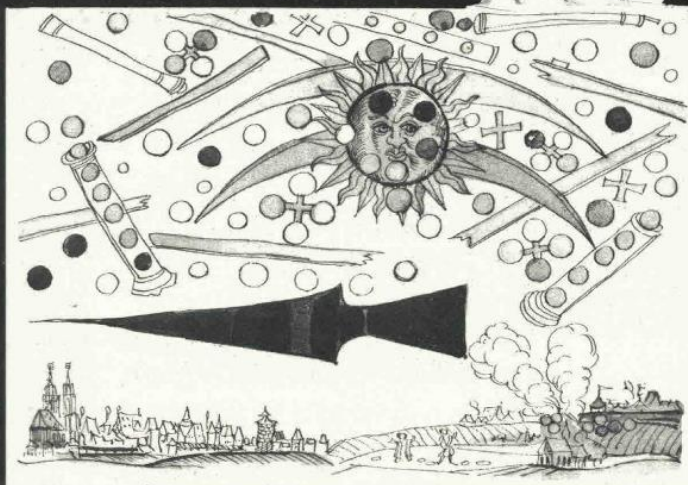
Eight years before that book was written, James Everett and two friends were sailing a barge along the Muddy River in Massachusetts when an enormous light dived from the sky. The power emanating from the light was so great that the boat was pulled upstream against the tide by an invisible force until, after some twenty minutes or so, the light vanished and the men were able to row to the shore.

## GREAT SPEED

In 1873 a large, cigar-shaped object flew at great speed over Bonham in Texas. The following day, what was apparently the same thing whizzed over the parade ground at Fort Scott, Kansas about 350 miles from Bonham. Once again it swooped low over the ground and flew off at great speed. To this day no-one has found a satisfactory solution as to what that object was.

Nine years later, in the early evening of November 17, 1882, Walter Maunder, an astronomer, was on the roof of London's Greenwich Observatory when he saw "a great circular disc of greenish light" which moved across the sky "as smoothly and steadily as the sun, moon, stars, and planets move, but nearly a thousand times as quickly". He described the object as an elongated ellipse "cigar-shaped or like a torpedo" — exactly the same description that was to be applied to many of the UFOs sighted in the twentieth century.

During the summer of 1917, John Boback was walking along a railway track in Pennsylvania USA when he heard a swishing sound to his left. Looking round, he saw to his astonishment that an elliptical craft had landed in a field



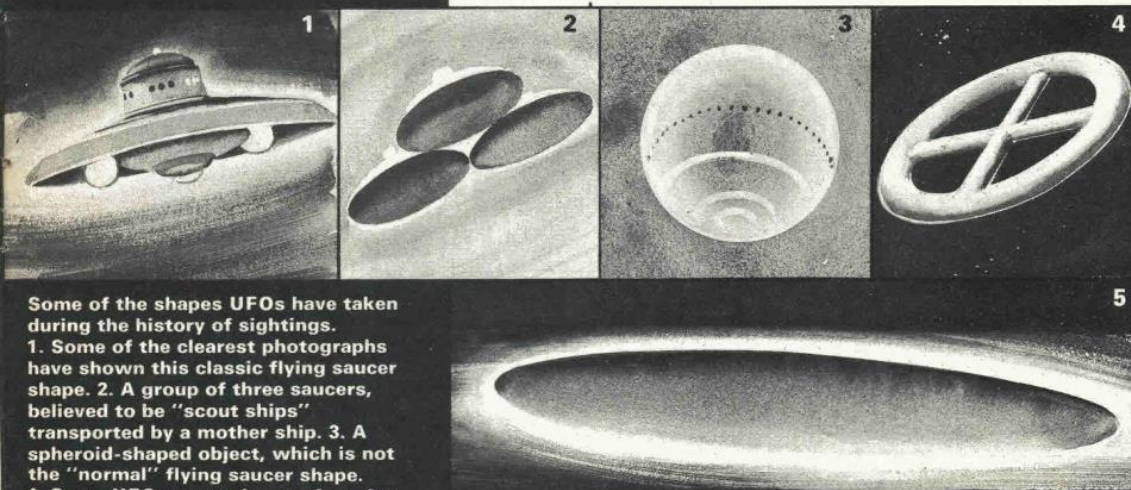
**Above:** American businessman Kenneth Arnold saw a whole formation of saucer-like objects from the cockpit of his light aircraft in 1947. His was the first of the modern UFO sightings, and the first reference to "flying saucers". **Left:** This is how early artists saw flying saucers, hundreds of years before Man's first flight!

less than a hundred metres from where he stood. A few seconds later the vessel lifted from the ground and flew off.

Six years later a flying saucer as large as a modern passenger plane and emitting a bright red light was seen hovering 200 metres above a main road near Indianapolis. Two men, who were later to become university professors, witnessed this event and a similar vessel was seen by two cattlemen in North Dakota five years later.

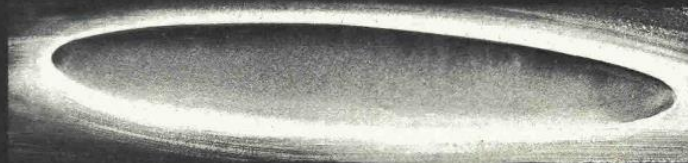
The first of the modern sightings took place on June 24, 1947. Kenneth Arnold, an American businessman, was piloting a private plane over a range of snow-capped mountain peaks when he saw a number of bright "saucer-like things". It was the first time that the word had been used to describe UFOs. "Flying saucer" has now become part of our language. But the mystery of what they are and where they come from still remains.

**NEXT WEEK: SPEED & POWER** examines further the baffling mystery of UFO's and looks at more true-to-life sightings of strange objects — don't miss your copy!



Some of the shapes UFOs have taken during the history of sightings.

1. Some of the clearest photographs have shown this classic flying saucer shape. 2. A group of three saucers, believed to be "scout ships" transported by a mother ship. 3. A spheroid-shaped object, which is not the "normal" flying saucer shape. 4. Some UFO reports have referred to science fiction space station shapes. 5. A super cigar-shaped UFO, it is thought to be a carrier of smaller saucers which scout ahead.





AS A CC-115 Buffalo transport aircraft travels down the glidepath on its final approach the crew are calling over the pre-landing checks. Height, distance, position and condition of the flaps and landing gear are all reported. But instead of "gear down and locked", the Captain radios "bag down and inflated". For this aircraft is fitted not with a conventional wheeled undercarriage but an air bag.

Such landings could become quite normal if trials now taking place in the United States are successful. Under test is the Bell Aerospace Air Cushion Landing System. It consists of a doughnut-shaped bag which can be inflated up to four times its normal size by a fan in the aircraft's fuselage. The air blown into the bag by the fan escapes through thousands of small holes on the underside of the bag. This provides the cushion of air which the aircraft floats on.

During touch-down, six brake skids at the bottom of the bag come into contact with the surface and slow the aircraft down. Because the area of the bag in contact with the ground is greater than the area of a wheeled under-

carriage, the stopping distance of a plane with this system is similar to a normal aircraft.

To do its job properly the bag has to be able to inflate easily and be able to wear well—a sort of cross between a balloon and a car tyre. To achieve this, Bell Aerospace have developed a special material—a combination of stretched nylon cloth, natural rubber and neoprene.

During flight the bag is deflated and fits tightly against the aircraft's belly, so that it will not affect the aerodynamic design of the fuselage.

## LOW PRESSURE

The air pressure in the bag is very low and this allows a plane fitted with an ACLS to land on surfaces like marsh, mud and sand, where normal undercarriages would bog down. Water, ice and snow also present no problems.

So an ACLS allows one aircraft to do the jobs that wheeled, ski or float-equipped aircraft do now, and also to fly into "no-go" areas where operations are at the moment impossible.

**Left: The Buffalo transport plane undergoing "static" and taxi tests fitted with an inflated Air Cushion Landing System. Scientists measure the power needed to enable the air cushion to support the plane's weight. Right: Fitted with ACLS, Buffalo and other supply planes could combine the jobs of aircraft fitted with wheels, skis or floats to reach areas which are "no-go" today, and even to land on aircraft carriers.**

Soon you could be seeing fighters and civil aircraft not with undercarriages and wheels but a rubber bag and a cushion of air! Then they could get to places which are "no-go" areas today.

# HOVER LANDER

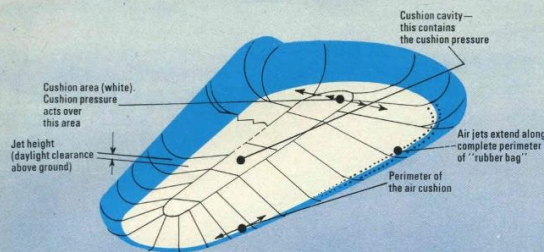
The first plane to be fitted with an ACLS was a small Lake LA-4 amphibian. This was used for a series of trials a few years ago and as a result of the experience gained on these trials it was decided to fit an ACLS to a medium-sized aircraft.

A CC-115 Buffalo was chosen and the equipment has now been tested. The air bag on the Buffalo is inflated by two fans which are powered by two small gas turbine engines, one mounted on each side of the fuselage. While the aircraft is in normal flight the ACLS is not required so the engines can either be shut down or used to provide additional thrust.

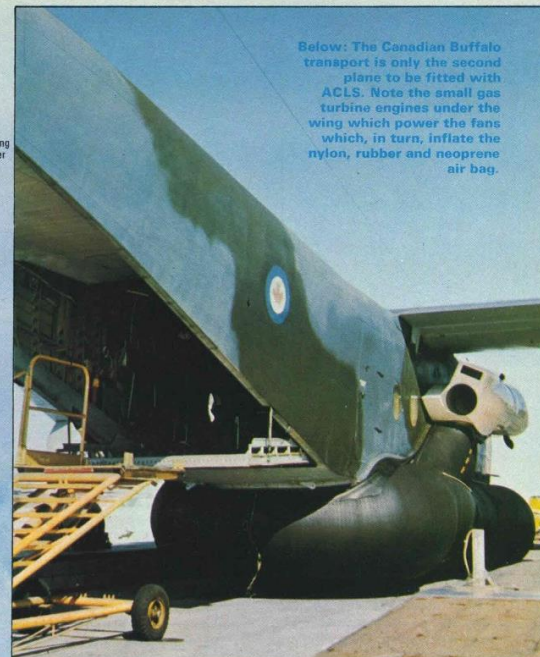
The future of the ACLS depends to a great extent on its performance in the trials about to start. Adopting the system would revolutionise the operation of many civil and military aircraft and allow them to go into areas which are now closed to transport planes, for instance, with normal undercarriages.

## FIGHTERS TOO

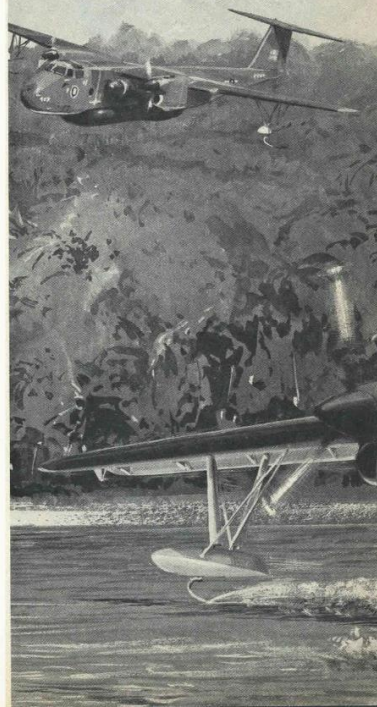
The system seems so versatile that Bell Aerospace have already undertaken studies into using the air cushion landing system on a NASA Space Shuttle vehicle and the Vought F-8 Crusader carrier-based jet fighter. If existing fighters could be easily modified, perhaps a great deal of money could be saved by not having to build special VSTOL (vertical and short take-off and landing) planes.



**Above: The air cushion acts over the area shown white. Fans operated by gas turbine engines on the plane's fuselage inflate the air bag and create an air cushion on which the whole plane and bag float when landing. Taxiing tests, with wheels off the ground (as shown in photo below), have so far shown the Air Cushion Landing System fitted to a De Havilland CC-115 Buffalo to be successful.**



**Below: The Canadian Buffalo transport is only the second plane to be fitted with ACLS. Note the small gas turbine engines under the wing which power the fans which, in turn, inflate the nylon, rubber and neoprene air bag.**





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12p Weekly No. 42 January 3-10, 1975

# Speed & Power

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STEAM &  
SPEED

WARPLANES  
OF THE WORLD  
*Great New Series*

CARS  
SHIPS TANKS  
SCIENCE  
FICTION

LET'S GO  
GO-KARTING





# HYDROGEN BURNERS

*We all know that world fuel stocks are running out fast, so new ways must be found to keep transport going. This story shows how scientists might solve the problem for the airlines, but more ideas are needed. You'll have your chance to tell us yours, as shown on page 7. Can a SPEED & POWER reader beat the crisis?*

**T**HE world is gradually running out of petrol. More crude oil is still being discovered every day, but not at the rate we are using it up. When no more "crude" comes out of the ground, all today's vehicles that run on petroleum will have to stop. This means almost every car, truck, train, ship and aircraft.

Most of the land vehicles can be replaced by ones that run on electricity, as do some modern trains. Electricity can be generated by coal, nuclear power and water turbines. But heavy cables cannot be coupled up to a jet flying at 40,000 feet! And there is no practical way of making aeroplanes and helicopters generate electricity on board, or to run on batteries. So things that fly will probably have to go on burning fuel, of some kind.

## WHEN GAS RUNS OUT

One good fuel is liquefied natural gas (LNG), which is a very easy liquid to convert to. Indeed some aeroplanes and helicopters are already trying it. But before long natural gas will also be exhausted. What then?

Far-sighted engineers say that, after the year 2010, more and more planes will have to run on liquid hydrogen (LH<sub>2</sub>). This is just ordinary hydrogen gas that has been made so cold that it condenses to a thin bluish liquid. But there is one big snag.

Liquid hydrogen is the *coldest* substance known. Hydrogen, the

Huge over-wing storage tanks could be the way to adapt today's aircraft like the TriStar to tomorrow's fuels. This is important, as aircraft are built to last and if they can't get kerosene, the airlines will have hundreds of millions of pounds' worth of aircraft sitting useless on the ground.

Here's how a future supersonic transport (SST) might look powered by liquid hydrogen. Huge tanks of this gas would have to be stored in the fuselage or in the wings. As the stuff is so cold, it has to have a lot of insulation so that it won't get too hot, boil off and escape. Gas lighter fuel is something like liquid hydrogen.

The next generation of airliners like the American SST may be designed from the start to use liquid hydrogen fuel. It could be much more efficient than kerosene, too.

lightest substance that can exist, has to be cooled to minus 423 degrees Fahrenheit before it becomes a liquid. This means that LH<sub>2</sub> has to be stored in heavy tanks with special insulated linings if it is not to boil off furiously and escape as a gas.

It also means that the liquid is dangerous! A drop could cause a severe burn, even though it would flash off into gas in the twinkling of an eye. Large quantities have to be handled with very great care indeed.

On the other hand, there is a bright side. There is a limitless supply, obtained by passing an electric current through sea-water

or by various other means. And LH<sub>2</sub> is a beautiful fuel. A given mass of it gives much more heat than the same mass of today's jet fuel (which is a blend of kerosene or paraffin). And LH<sub>2</sub> burns very sweetly with no pollution.

## LESS FUEL, MORE HEAT

Another big advantage of LH<sub>2</sub> is that, as it gives more heat than the same mass of today's fuel, aircraft would not need to carry such a heavy weight of fuel. They could be made lighter, and have smaller wings. Engines could also

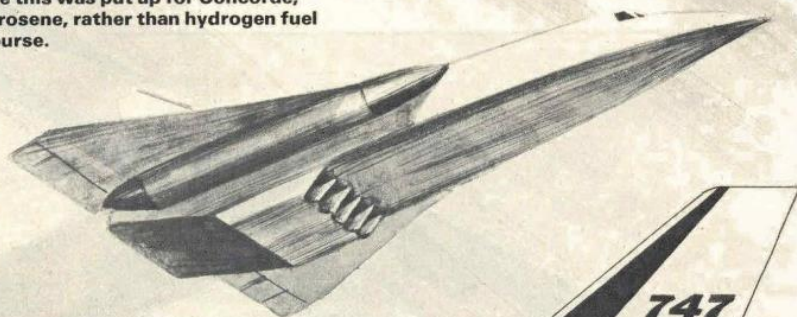
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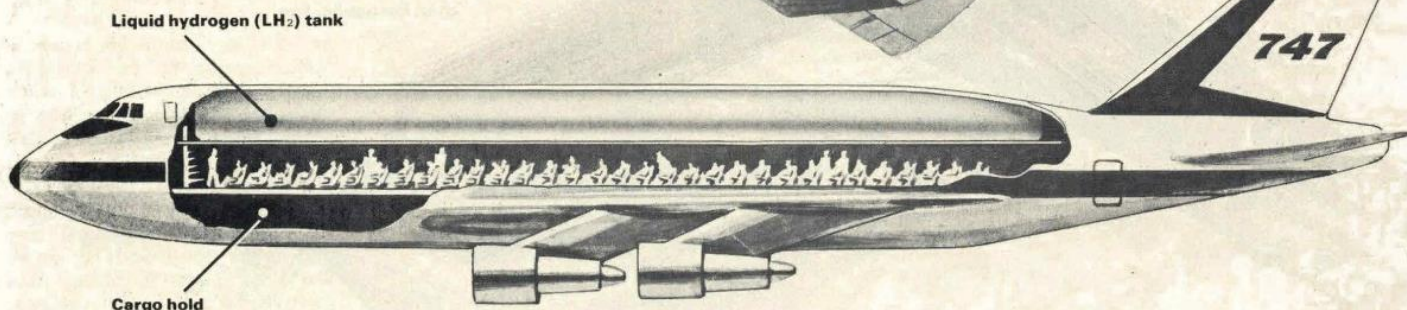
**Right:** There are many ways that liquid hydrogen could be housed in an aircraft designed to use just this new fuel. Here, a Concorde-type airliner has a large tank built into the wide, flat-bottomed fuselage. Making up for the space it takes, liquid hydrogen ( $LH_2$ ) is cleaner than today's fuel.



**Below:** Another way to do it. By storing the liquid hydrogen in long cigar-shaped fairings under the wings, the engines can be set under the fuselage where they're easy to service. A design like this was put up for Concorde, but with kerosene, rather than hydrogen fuel tanks, of course.



**Below:** So that modern airliners don't end up as so much scrap metal when the fuel they were designed to use runs out, scientists are working hard on adapting them to hydrogen burners. This Boeing 747 has a big tank of it above the passenger cabin.



be made much more efficient, giving more power from a smaller size.

For supersonic aircraft, a further advantage is that the intensely cold fuel could form an ideal way of keeping the whole aircraft cool, as friction is created by the plane rushing through the air.

## LIQUID DISADVANTAGE

Unfortunately there is one big drawback to liquid hydrogen as an aircraft fuel (though it is much less of a problem with ships, trains and trucks). This is that, as it is basically the lightest substance known, the liquid has a very *low density*. A ton of liquid hydrogen takes up far more room than the same mass of today's fuel. In comparison with modern jet fuel, it needs eleven times as much space!

This is no problem with large aircraft designed to fly short distances, but for long-haul jets, supersonic transports and military aircraft it poses big difficulties. In

such aircraft there just is no empty space at all. So to get in eleven times the bulk of fuel the whole aircraft must be redesigned. Most of its volume will have to be fuel tankage, not passenger room or cargo stowage.

Lockheed-California Company have suggested how their new TriStar airliner might be converted to burn  $LH_2$ . The simplest way is

to leave most of the aircraft as it is and just add two huge liquid-hydrogen tanks above the wings. It looks as if the plane would be terribly overweight, but in fact it would weigh rather less than before (even allowing for the huge, thickly insulated tanks), and it could have smaller wings.

Boeing have done a similar study on their big 747 "Jumbo

jet". In this case they would build a new fuselage with an enormous tank for about 24,000 cubic feet of the freezing liquid just above the heads of the passengers!

Another Lockheed study features an SST (supersonic transport). In this case the colossal hydrogen tanks are actual sections of fuselage, with the passengers in between them.

## USED FOR MOONSHOTS

Of course, a tremendous amount of new engineering will be needed before the hydrogen-burning aircraft start carrying passengers, but most of the basic technology already exists. Space rockets have run on  $LH_2$  for years, and there were many hundreds of tons of the stuff aboard every Moon-shot.

All that has to be done now is to find a way to produce it at a competitive price, and handle it at airports as easily and safely as we do today with the old fuel that before long will be in museums—kerosene.

**This sketch shows the size overwing tanks of liquid hydrogen would need to be to power the Lockheed TriStar. Each tank is 10.4 feet in diameter and they carry all the plane's fuel. This has the advantage of taking loads off the wing as the fuselage is lighter. On the other hand, the tanks may create aerodynamic and stress problems. But the new fuel is lighter—98,000 pounds compared with 391,000 of conventional fuel for a 1981 SST.**





# 'Pocket Destroyer'

She might be just a little'un, but this new Vickers destroyer could have a surprise in store for an enemy—she's got as much firepower as bigger warships!

Key (one design proposal)  
1. Four Exocet surface-to-surface missiles. 2. Twin 35mm anti-aircraft gun. 3. Two sets of triple homing-torpedo launchers. 4. Exhaust outlet. 5. Bridge. 6. Navigation, communications, radar and weapons control systems. 7. Medium range 4.5in. gun. 8. Bofors twin 375mm rocket launcher. 9. Combined diesels and gas turbine power units. 10. Mess and other living quarters.

400 average family cars! Cruising range at an economical speed would be around 4,000 nautical miles.

There are two types of the mighty midget destroyer under development now, about 1,000 and 1,100 tons displacement, and there is a possibility of other versions. They have been designed specially for small crews, easy maintenance and low cost.

The hull is cheaper but more robust than those of other warships, and the number of men needed on board will also be much fewer.

There will be about 75 officers

and men, and they will be equipped with the most modern air surveillance and navigation instruments, and target-tracking radar, plus Sonar—Sound Navigation and Ranging gear. Their quarters will be comfortable, too, and all living and working spaces will be air-conditioned.

## BAD WEATHER TESTS

It will also be a comfort to the crew to know that Vickers have done a lot of testing with scale models of the destroyer in water tanks with artificial "waves", and that the *Vedette* showed it could operate in bad weather in a way you would normally expect of a much larger warship.

*Vedette's* crew will have the very latest electronic equipment to help them navigate, track their enemy and aim and fire their weapons.



But who will use the ship? Well, any medium-sized or even larger navy wanting to buy it! And that includes, of course, Britain's

Royal Navy which, if given the go-ahead to buy, would ensure the success of yet another super Vickers warship.

**FACTS AND FIGURES (estimated)** Length, 270ft. Waterline length, 250ft. Width, 32ft. Displacement up to 1,100 tons. Maximum speed, over 30 knots (33mph plus). Range, at 16 knots (18mph), up to 4,000 miles.



**Y**OU WOULD think a modern cruiser was a massive warship—and most of them are. The Royal Navy's County Class destroyers, for instance are about 520ft. long. Pace that out along the pavement next time you're out and you'll begin to get the idea!

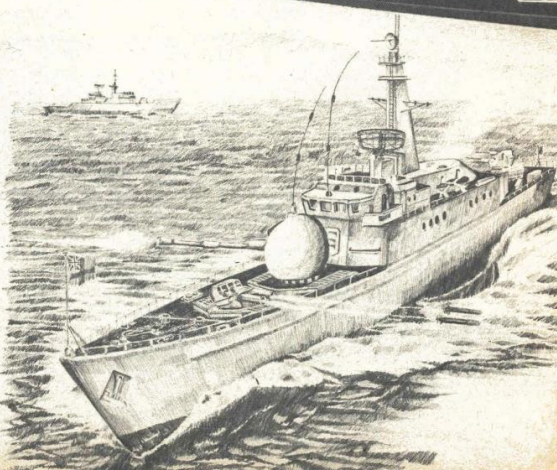
And yet you would be able to get *two* of Vickers' latest destroyers designs along the deck of one County Class vessel. The famous British shipbuilders have really squeezed a quart into a pint pot, for their *Vedette* will pack as big a punch as many much bigger warships.

On board will be the most advanced weapons, including surface-to-surface missiles, twin anti-submarine rockets and torpedoes, mountings for surface-to-air missiles, a 4.5in. or 5in. automatic gun, and 35mm or 40mm rapid-fire guns for close range anti-aircraft

defence. All that is some formidable fire power!

*Vedette* will be fast, too. Fitted with Twin Paxman diesel engines plus a Rolls Royce Olympus marine gas turbine for high speed boost, she'll slice through the waves at over 30 knots (33mph plus). This propulsion arrangement is called CODOG—combined diesels and gas turbines. It would give the "pocket" destroyer a total shaft horsepower of 25,000—the combined horsepower of more than

Although she will be only a small destroyer, *Vedette* will pack as much punch as many larger warships. She'll have a robust hull, and will have very powerful engines, combining diesels and gas turbines, which will thrust her through even rough seas at high speeds, 30 knots and more.



1. Is the MRCA a delta- or swing-wing aircraft?
2. Is a "SAM": a tank, an aircraft or a missile?
3. Do the US Navy use Sea King helicopters?
4. What is the most westerly British Rail station in England: Truro, Penzance or Fishguard?
5. What was the maximum speed of the Hawker Tempest II: 442mph, 163mph or 660mph?
6. Which of these is not a US-built aircraft: Voodoo, Corsair, Super Sabre, Draken?
7. Where will you find *HMS Belfast*: New York, London or in the Atlantic Ocean?
8. In what year did the first man in space, Yuri Gagarin, make his historic flight?
9. Which two large countries are co-operating in the Skylab space station project?
10. Which is Britain's busiest railway junction: Clapham Junction, Watford Junction or Llandudno Junction?



Second prototype of MRCA making its first flight at Warton Lincs.

**Quick Quiz?**  
Test your knowledge of transport subjects with these tricky questions. The answers are on Page 31.



12p Weekly No. 43 January 10-17, 1975

# Speed & Power



**HEADFIRST**  
at 150 mph!



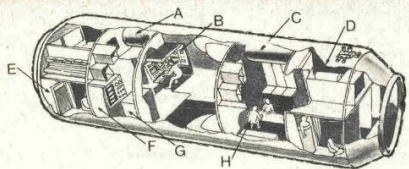
**TOMCAT**

**SPACE TANKS**  
**MODELS**  
**SCIENCE**  
**FICTION**

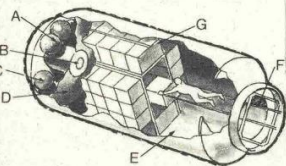
**SCIMITAR**  
*The Navy's high-speed trainer*



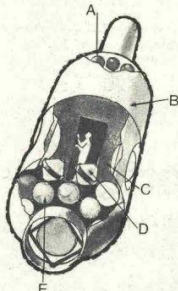




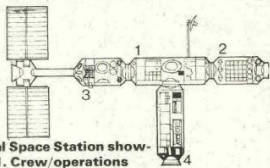
**Unit 1: Crew/operations module**  
A. Hygiene trunking. B. Command control console. C. Hygiene. D. Crew quarters. E. Crew quarters. F. Electronics. G. Environmental control and life-support systems. H. Galley and wardroom.



**Unit 2: Logistics (freight-handling) module.** A. Propellant cargo. B. Crew transfer tunnel and airlock. C. Liquid gas cargo. D. Pressure dome. E. Special cargo space. F. Cargo handling aids. G. Solid cargo.



**Unit 3: Power/Subsystems Module.** A. Propellant tankage. B. Electrical power supply. C. On-board check-out. D. Control moment gyros. E. Atmosphere supply.



**Initial Space Station showing:** 1. Crew/operations module. 2. Logistics module. 3. Power/subsystems. 4. General-purpose lab.

Looking like a giant "space tree", the modular space station orbiting Earth could be the next step Man takes in exploiting space. Complete modules containing laboratories, power sources, crews' quarters, etc., would be ferried up to the ISS (Initial Space Station) by the Shuttle, and "docked" in. Astronauts would not have to go outside into space except, perhaps, to check a faulty connection.

# Building in Space

*Could Man ever live permanently in space? Scientists are taking a few steps nearer the answer with their studies into the space station which can be added to in orbit—like a giant model kit.*

ON CERTAIN nights when the weather is clear, a small bright star can be seen moving steadily across the sky a little above the southern horizon. Some newspapers regularly report the predicted times of that passage because the star is Skylab, America's first experimental space station and now a dead, empty hull, its purpose completed. That purpose was to be the forerunner of the next inevitable step in the exploitation of space—permanent bases in Earth orbit.

Most of us probably imagine a space station as a giant cartwheel

slowly revolving so that centrifugal force provides "gravity" to living quarters in the "rim". The "hub" would be despun to ease spaceship docking. This idea is certainly logical and may in the long run serve as a way-station for lunar and planetary flights. But what we shall see first is something much more modest.

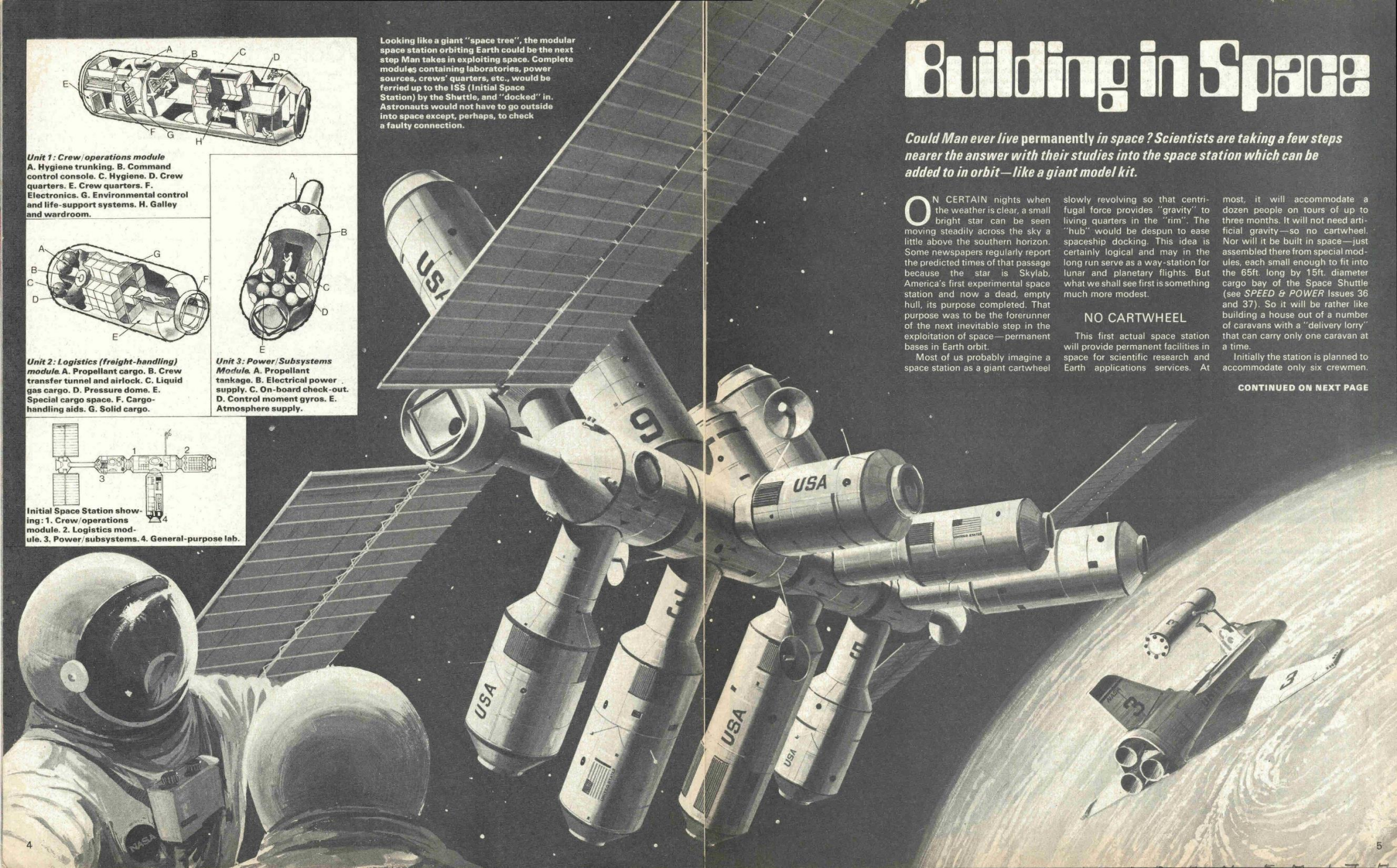
## NO CARTWHEEL

This first actual space station will provide permanent facilities in space for scientific research and Earth applications services. At

most, it will accommodate a dozen people on tours of up to three months. It will not need artificial gravity—so no cartwheel. Nor will it be built in space—just assembled there from special modules, each small enough to fit into the 65ft. long by 15ft. diameter cargo bay of the Space Shuttle (see *SPEED & POWER* Issues 36 and 37). So it will be rather like building a house out of a number of caravans with a "delivery lorry" that can carry only one caravan at a time.

Initially the station is planned to accommodate only six crewmen.

CONTINUED ON NEXT PAGE





### GENERAL-PURPOSE LABORATORIES MODULE

This module docks into the Crew/Operations Module (as shown on page 4, Unit 1). Carried out here are experiments and analysis of experiments performed in other space station modules.

**Electronic/electrical laboratory, in which electronic equipment and other instruments are checked.**

**Biomedical/bioscience laboratory which, among other things, checks the health and well-being of the crew.**

**Experiment and test isolation laboratory, including scientific airlock, remote operations controls and chemicals experimental lab.**

**Mechanical laboratory, in which materials are tested and analysed.**

The assembly programme begins with the launch of a Shuttle carrying the station's nerve-centre—the power and subsystems module.

This is a chamber about 30ft. long and 14ft. in diameter containing gyroscopes and fuel to control the station's equipment. From one end protrudes a 30ft. mast carrying a pair of giant wings—solar arrays unfurled after launch to generate electricity from the Sun's rays.

The next flight, a month later, brings up the crew accommodation module. This is the largest unit, 45ft. long or more and houses the main operation control room as well as crew accommodation. It is dotted with hatches, one at each end and three, possibly four, around the centre section.

### ASSEMBLY CREW

The unit is fitted end-on to the end hatch of the power module, also equipped with three or four centre-section hatches. Two assembly crew come up with the modules, their Shuttle waiting a couple of days while they link up interconnections, switch on power

and test all the equipment.

A basic spaceship now exists, orbiting empty for another month until the next load arrives. This is a general-purpose laboratory and, when it has been plugged into one of the centre-section hatches on the crew module, we finally have a useful and complete space station in its own right.

It is with the fourth flight that the first operational crewmen arrive—scientists with perhaps two astronauts to operate the ship. The Shuttle carries only four passengers, so probably three people—half the crew—come initially. The others arrive a month later, and in the third month the first three crew are replaced.

But, more important, each of these crew flights will also bring up supplies of spare equipment,

food, water and oxygen, all loaded in a special logistics module—a kind of freight container—which is rather shorter than the other units, so that two could be carried in the Shuttle cargo bay if necessary. These are simply plugged in to other centre-section hatches and replaced on the next Shuttle visit.

### BUILT IN ORBIT

Of course, it would be simpler to design a large single-unit station, but this would have to be carried up in pieces and actually built in orbit. The cost and complexity would be much greater.

The modular station shown here is simply docked into the next by the Shuttle, to which it remains attached until the manoeuvre is

completed. There would be no need for assembly crewmen to go outside into space except, perhaps, to check a faulty connection.

Flexibility of size is the biggest advantage of the expandable space station idea. The station would not remain a six-manner for long. Later on it would simply be doubled up. It would then comprise a central core of two crew modules (for 12 occupants) plus a power module with its solar array at each end.

The core, however, would bristle with an assembly of laboratories, research modules and supplies containers, hence the bottlebrush effect. And in that form alone, it should satisfy all the space research and applications requirements of the Western world for at least ten years.





# AIRPORT OF THE FUTURE

*Imagine an airport many, many times bigger than London's Heathrow. Two hundred Boeing 747s land at the same time and there's room for them all. In the American state of Texas, there is such an airport—a vast 26 square mile skyport of the 21st Century . . .*

ON THE vast Texas plain, between Dallas and Fort Worth, the airport of the future is today rapidly taking shape. Everything in Texas is big and this jumbo-sized airport will be no exception. Scheduled for completion in the year 2001, the Dallas/Fort Worth Airport will be the largest in the world and will cover almost 17,000 acres. It will be able to load and unload over two hundred jumbo jets at any one time and it is expected that over fifty million passengers will pass through the airport each year. In

**By the time Dallas/Fort Worth airport is fully in use, aircraft, as well as their bases, will have changed. This odd-shaped Jumbo has 1980s super streamlining.**

addition there will be two completely automated cargo centres, each capable of accommodating over two hundred aeroplanes every day of the year.

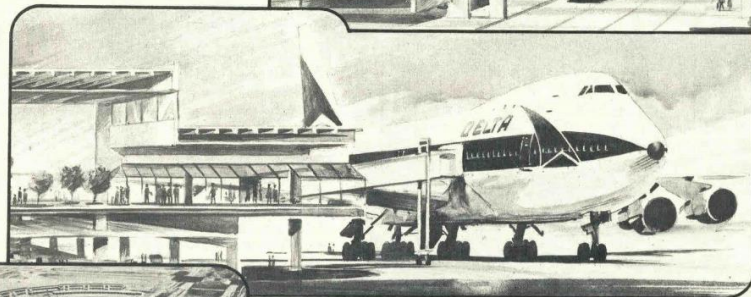
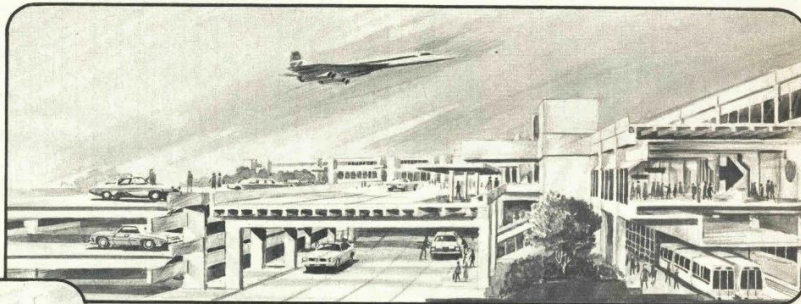
In order to cope with the vast number of passenger planes, there will be thirteen crescent-shaped terminals each of which will be

**CONTINUED ON NEXT PAGE**



# AIRPORT OF THE FUTURE

CONTINUED



Above: A Boeing 747 hooks up to one of the "docks" at Dallas/Fort Worth. When all 13 passenger terminal complexes are open, each will be able to take up to 22 aircraft each—up to 286 planes loading and unloading at a time! Left: This photo gives you some idea of what part of a 17,500-acre airport looks like. Taken before the first of the terminals was opened, the 196 foot control tower and some of the access roads are finished. The roads will enable passengers to drive almost right up to their planes.

able to deal with up to eighteen aircraft at a time. The use of these semi-circular terminals allows for future expansion because they are connected by a central roadway and when additional terminals are required, they will simply be built further down the road.

## HANDY TERMINALS

Each terminal will be up to 3,000ft. long and 125ft. wide. Their design also reduces quite dramatically the distance that passengers have to walk, for, instead of having to make their way through the maze of corridors that typify most airports of the world, they will only have 330 feet or so to travel from the car park to the aircraft. So, time-wasting queues should be almost eliminated.

To move passengers within the

airport, from terminal to terminal, there will be an internal transport system, *Airtrans*, the first of its kind in the world. This will consist of over fifty electrically-powered vehicles, or "people movers," which will carry passengers between 53 stations.

Running on rubber tyres in a concrete guideway, the automated transporters will take only a few minutes to travel from one station to another. This system, which will also be used for transporting luggage, mail, and refuse, will form a vital link between flights for people that have to change planes at Dallas/Fort Worth.

Computers were used extensively in the design of this mammoth airport. Planners simulated what would happen if the sky above Dallas were saturated with planes, and had the computers

calculate the number and length of runways that would be needed to clear the sky, and the number and design of taxiways that would then be required to clear the runways.

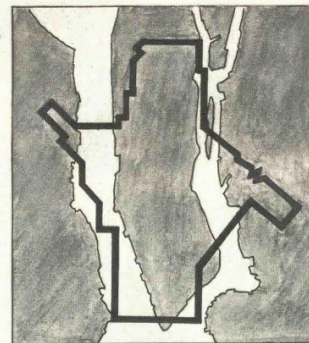
## COMPUTER PLANNED

The next problem to be solved by the computers was the number of gates and terminals necessary to handle the immense number of passengers that would be using the airport each day. Even the car parks were planned by computers which estimated that by 1975 at least 20,000 parking spaces would be needed.

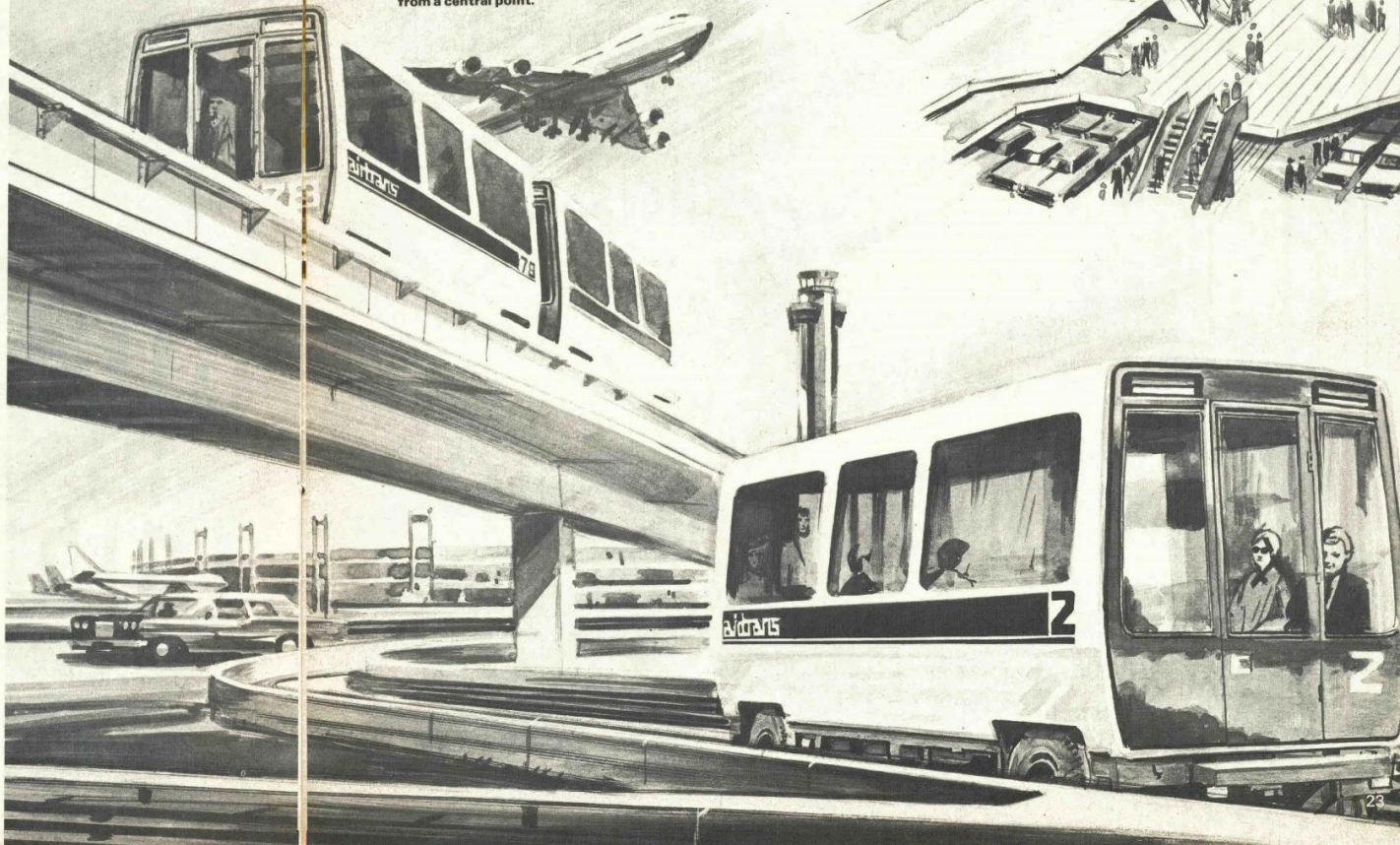
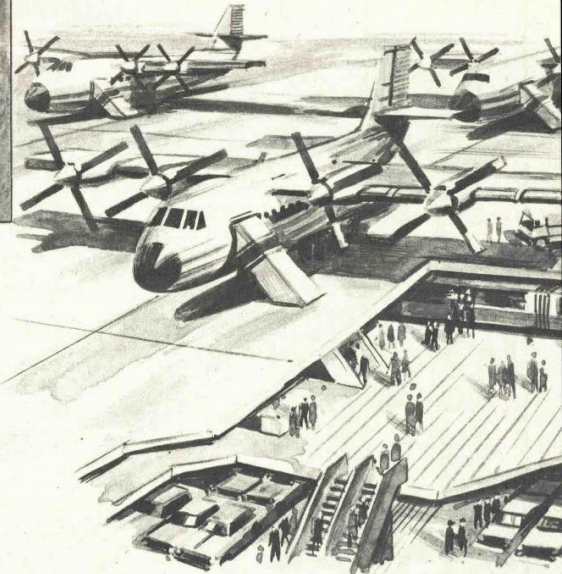
Progress towards the complete airport of the future is being made in four stages. The first phase, consisting of four terminals and three runways, was opened in September 1973. American Airlines and Braniff International were two of the first airlines to use the new skyport.

Stage two will be completed in 1975 when the airport will be able to handle 275 jet take-offs and landings each hour, and fifteen million passengers a year. Ten years later, when stage three is completed, it will have additional runways and handling facilities to deal with the ever increasing flow of air traffic. By 2001, the Dallas/Fort Worth complex will be complete and coping with the problems of travel in the 21st century.

Right: When all the work is done, Dallas/Fort Worth will be the world's largest airport by a wide margin. This diagram shows the total area of it imposed on a map of New York. Taking up about 26 square miles of land, the airport is almost as long and much wider than Manhattan Island. Some of it is open now, but it will not be fully operational until around 1985. Below: No walking at Fort Worth! So that passengers are able to move quickly and comfortably around the airport, an automatic transport system, called "Airtrans" has been installed. The first of its kind in the world, Airtrans has no drivers. The cars are remotely-controlled from a central point.



Below: As well as handling airliners, the airport will have plenty of space for freight, business and light aircraft. Here, passengers board their flight from an underground lounge, with their cars parked another floor down. If each type of aircraft has its own area, timetables are not thrown out by large and small planes waiting to take off from the same runway, as happens at many airports today. Fort Worth/Dallas should have few queues, if any.





**WIN A  
HARRIER!**

**In our FREE-TO-ENTER  
COMPETITION**

12p Weekly No. 44 January 17-24, 1975

# **Speed & Power**

**20 Jump-Jet  
Model Kits  
to be won**

Plus 40  
other kit  
prizes



**CARS PLANES SPACE  
SHIPS TRAINS  
SCIENCE FICTION**



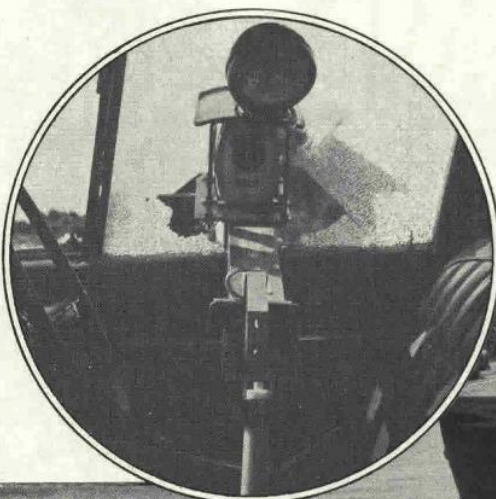
# ROBOT BOMB-HANDLER

The Army has a new "Wheelbarrow"—one that saves lives!

**N**ICKNAMED "Wheelbarrow" this ingenious little "tank" has been built by the Army as a "life-saver" for their bomb disposal squads who have to render harmless lethal explosives planted in boxes, cars, and even houses. Using the remotely-controlled "Wheelbarrow", suspect items can be examined at a safe distance and then removed, or exploded on the spot. Basically the machine is a tracked trolley steered and operated through an electric cable connected to a remote-control box. The trolley mast carries a TV camera and spotlight which relays a picture to a monitor screen placed beside the operator. The

trolley is driven by battery-powered motors and the boom on the mast can be fitted with a number of special attachments. Aside from the ones shown here, it can carry a grapnel hook and place it under a suspect car before running out a tow rope so the car can be moved away from property that could be damaged in a blast. Wheelbarrow can also climb stairs and be used to examine the inside of houses suspected of being booby-trapped.

*Photos: courtesy MOD*



**Above:** Wheelbarrow approaches a suspect car and shatters a window so the TV camera can scan inside (inset). If the car is "mined" then the white explosive charge hung beneath the boom is released and Wheelbarrow withdraws, running out a firing cable to blow the car up.

**Above:** Remotely-controlled pincers can be fitted to the boom and used to remove suspect packages, like this dustbin. Right: A repeating shotgun can be fitted to the boom to blow open small parcel bombs. This dummy bomb, placed on an ammunition train, has just been blasted. The mast and boom are controlled by hydraulic rams so the gun can be aimed.





# Getting to the bottom of it!

Whoever heard of TV cameras underneath ships? Well, special mobile units, like the one shown right, will soon be doing a vital job inspecting the hulls of ships...

RUNNING the massive 400,000-ton tankers that form an important part of the world's cargo vessels is an expensive business. To make money the owners must ensure that each ship is able to "work" at all times.

One way in which this is achieved is to place each vessel in dry dock at least once in every two years to carry out a full-scale inspection of the flat-bottomed hull for damage. But this dry docking and inspection operation takes time and costs a lot of money.

But it now looks as though these problems will soon disappear, thanks to an ingenious, remote-controlled underwater device called *Scan*. Developed by the Atomic Energy Research Establishment at Harwell in conjunction with Underwater Maintenance Co. Ltd., the British firm that devised it, *Scan* is able to inspect the hull of a tanker while it is still afloat. This does away with the need to dry dock the vessel for inspection. And, because it is easily packed up and transported, it can be taken to the tanker instead of spending money on taking the tanker somewhere special for its check-up.

## SAUCER-SHAPED

The device consists of a flying saucer-shaped vehicle which runs along underneath the hull of the ship on three rubber-tyred wheels. Buoyancy tanks of compressed air ensure that the trolley is pressed firmly up against the tanker bottom.

*Scan* is driven by two variable-speed hydraulic motors on two of

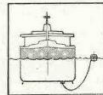
its wheels and is controlled from the surface through a cable. The operator directs *Scan* using grid lines painted on the hull or by keeping an eye on the welding seams to identify the area in which he is working.

## TV PICTURES

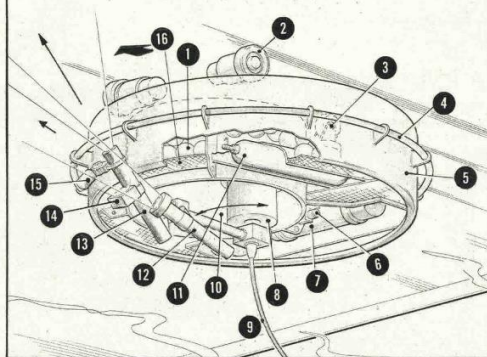
Lights in the space-age trolley illuminate the hull and television pictures are transmitted from two cameras, one giving a general view and the other being used for

close up pictures. These are relayed to TV screens on board the control boat. *Scan* also carries a 35mm still camera for photographing specific areas.

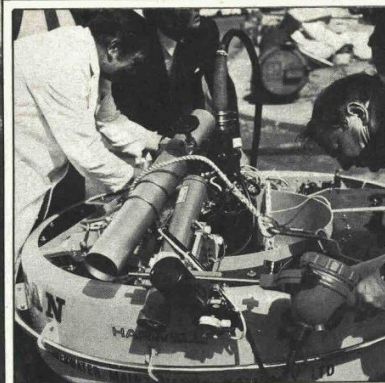
At present the device has just completed its sea trials and in October 1974 it was on show for the first time, at the Offshore International Exhibition in London. Shipping owners are already so confident that *Scan* is the answer to their inspection problems that many of them have marked grid lines under their tankers.



**KEY TO DRAWING OF SCAN VEHICLE:**  
 1—Buoyancy spheres. 2—Drive wheels and motors. 3—Guide wheel. 4—Handling rail. 5—Glass fibre body. 6—Control valve. 7—Electric motor. 8—Pan drive. 9—Control cable. 10—Buoyancy tank. 11—Air bottle. 12—Long range TV camera. 13—Close-up TV camera. 14—Light. 15—Still camera. 16—Perforated returning plate.



Photos: Underwater Maintenance Co.; A.E.R.E. Harwell.

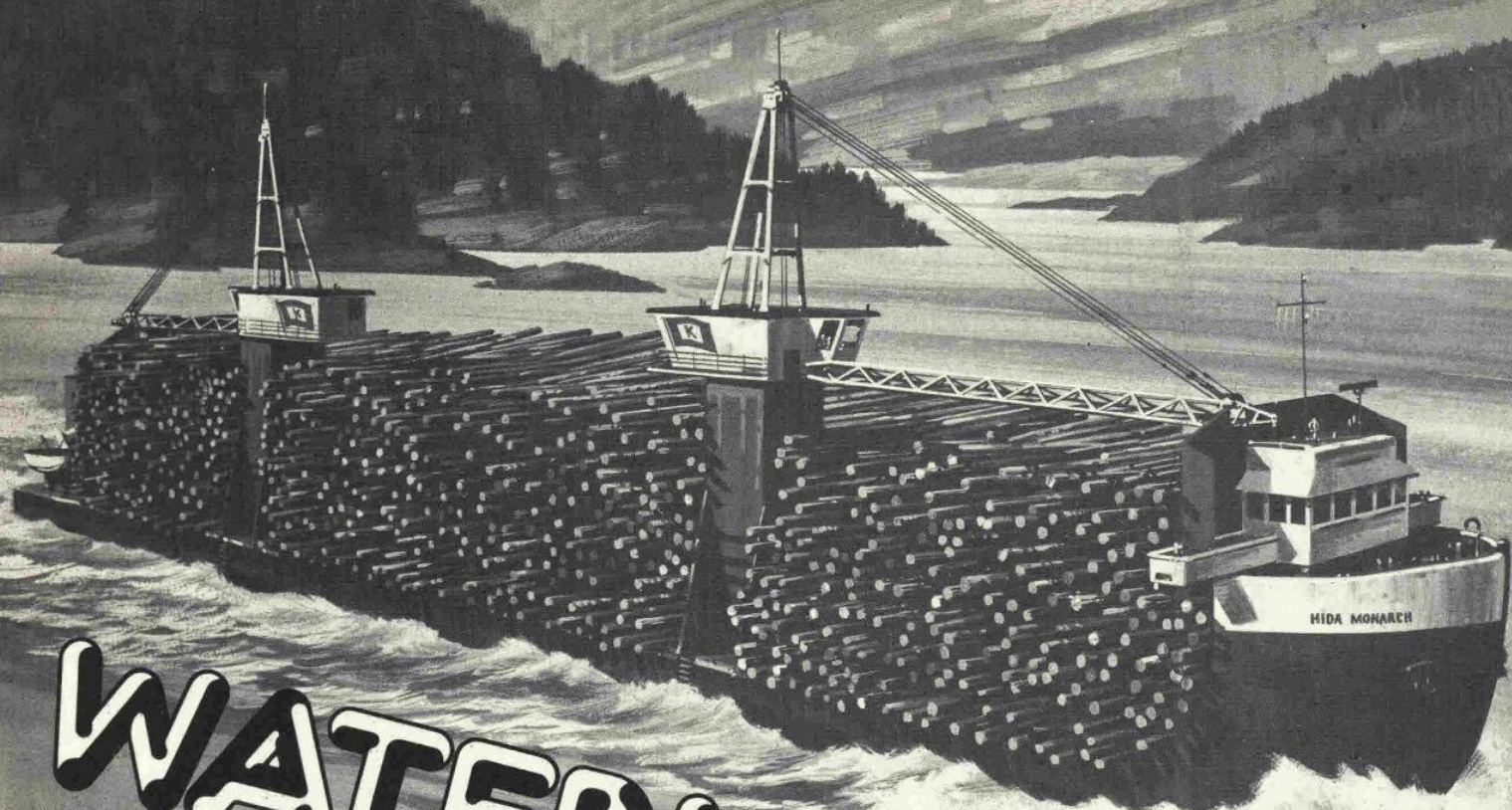


Above: Mechanics prepare the custom-built *Scan* vehicle. Look at those special TV cameras and still camera—all specially waterproofed of course!



Above: Underside of the strange unit, showing the drive wheels that run along the underside of ships (*Scan* will be upside down when operating).





# WATERLOOCCED!

## The story of 20,000 ton lumberjacks

A unique self-dumping log carrier—capable of carrying many thousand tons of logs at nerve-wracking angles—is bringing a new look to the logging industry on the West coast of Canada...

IN HIS BRIDGE high over the forecandle of the 20,000 ton ship, the Captain sat in the pilot chair and peered out, not forward over the flat waters of the British Columbian inlet, but through the windows at the back of the bridge at his cargo. He was looking at nearly five million feet of timber stacked on his deck in a huge pile more than thirty feet high!

This was not the neat sawn wood that we buy from the timber merchants, but enormous rough barked trees, freshly cut from the great Canadian forests, some with trunks more than five feet thick and each weighing tons.

As the Captain watched, the ship slowly began to tip to one side, almost as if she was about to sink. Higher and higher the starboard side of the ship rose out of the grey waters. Lower and deeper the port side dipped into the sea.

### REMARKABLE SHIP

We were watching not the last plunge into the depths of some stricken vessel, but the normal unloading procedure of a remarkable ship now ready for work on the West coast of Canada. The ship has been built to carry loads of giant logs down the coast of British Columbia from the remote forests to the mills where the logs will be converted into paper

and pulp. It is a complete "do it yourself job"—self-loading, self-propelled and self-dumping. Let's rejoin the Captain on his bridge as the "moment of truth" approaches.

### STEEPER

As the list of the big ship gets steeper, the Captain carefully studies the surface of the log pile, looking for the slightest signs of movement. With one ear he hears the voice of the Mate reading from the clinometer. The ship is now tilting a crazy thirty degrees—a list which would, on other ships, have seamen running for the lifeboats!

Down in the engine room, the chief engineer looks anxiously at his temperature gauges. Machinery works at its best when level and although the main generators on the vessel have been specially adapted to work in a steep list, they need careful watching. The great pumps that are pushing water out of the high side of the ship are gradually slowed down at the Captain's command.

In the galley the cook notes with approval that the stove which has been built in gimbals

Above: A self-propelled, self-loading log carrier powers its way down river with another full load. Developed by MacMillan Bloedel of Canada for its Kingcome fleet, it is used mainly to transport logs from the Queen Charlotte Islands to mills on the lower mainland of British Columbia. Twin cranes allow self-loading where shore equipment far upriver is often primitive or non-existent.

is remaining the the only level object in the tilting world. A bell rings, signalling the engineers to stop all pumping. At the Captain's voice over the loudspeakers, all hands make sure of their hand and footholds. A last check to make sure nothing is loose...

As the noise of the pumps dies away, there is a momentary pause, then sheer bedlam takes over as the cargo begins to pour down the steeply sloping deck.

CONTINUED ON NEXT PAGE



# WATERLOGGED!

CONTINUED

There is a creaking and tearing and splintering, a noise like thunder as the logs pour over the side in a cloud of spray. The vessel rapidly rises out of the water as the huge weight leaves her.

## CONFUSION

As noise and confusion dies away, the Captain notes with approval that every log has gone and only dirt and strips of bark remain on the huge clear deck of the ship. But the once-smooth waters of the inlet are filled with the vast pile of logs literally fighting to come to the surface in an awe-inspiring turmoil. With a grunt of satisfaction at another cargo delivered, the Captain gives the orders to bring his ship fully upright ready for the return journey to the North.

The big log carrier is a development of the self-dumping log barge which has been

carrying British Columbian logs to the mills for a number of years. The main difference is that the new craft is much bigger than any barge, she will have a crew aboard all the time and, self-propelled with two powerful engines, she will not require the services of tugs. The ship has had to be designed to completely new standards both to ensure the safety of the crew during the violent motions of the cargo discharge and to compensate for the enormous stresses set up as a 15,000 ton weight falls off the ship.

The new ship will join a fleet of huge towed log barges that carry the trees for the paper and pulp mills from the hard-to-get-to areas of the British Columbian coast and its offshore

islands. There is little in the way of port facilities at these forestry outposts. The vessels are all equipped with powerful whirly cranes which can lift the logs in steel grabs out of the holding ponds where they have been floating. Sometimes five or six mature trees can be lifted in the huge jaws of these specially designed grabs.

## MODERN CRAFT

Craft such as these are typical of the modern logging industry which has advanced a long way from the "man with an axe" of the past in an effort to keep up with the growing world need for forest products.

The industry is now highly mechanised, from the huge multi-wheeled tractors that trundle around the steep forest tracks with loads of logs, to the powerful saws that bring the trees crashing down. There are mobile

machines for stripping off the branches of the trees, as quickly and with as little apparent effort as stringing a runner bean.

Some of the bravest men involved in what was once a hazardous industry were the men who made up the rafts in the log ponds, riding the logs with spiked boots and balancing poles. These timber men led a charmed life, in constant risk of being crushed between two huge logs.

## DANGEROUS JOB

This dangerous job has, happily been taken over largely by comical looking "logdozers", powerful and almost round craft which can push the logs around without risk to anyone. Highly manoeuvrable and capable of moving in any direction, the logdozer is tougher than it looks. With its driver snug in his little cabin the logdozer fusses around the log raft, bodily shoving about great bundles many times its own weight; inserting its bluff bow between huge logs and rudely pushing them apart. With its noisy diesel and single propeller churning up the water, the logdozer may not be so romantic as the old log-jumper, but it is a lot safer!



Below: With a crack like thunder the load of freshly-felled logs pours over the steeply-listing side and into the grey waters, throwing huge clouds of spray high into the air. Above: Gone are the days of the log-jumpers with their spiked boots and balancing poles. Now a small fleet of diesel "logdozers" rounds up the huge raft of trees.





# SPECIAL DELIVERY

## ARTHUR C CLARKE



*When the astronaut saw the early stages in the construction of the space station, prefabricated parts were floating around in hopeless confusion. It seemed impossible that any order could ever emerge from this chaos.*

I can still remember the excitement, back in 1957, when Russia launched the first artificial satellites and managed to hang a few pounds of instruments up here above the atmosphere. Of course, I was only a kid at the time, but I went out in the evening like everyone else, trying to spot those little magnesium spheres as they zipped through the twilight sky hundreds of miles above my head. It's strange to think that some of them are still there—but that now they're *below* me, and I'd have to look down toward Earth if I wanted to see them...

Yes, a lot has happened in the last forty years, and sometimes I'm afraid that you people down on Earth take the space stations for granted, forgetting the skill and science and courage that went to make them. How often do you stop to think that all your long-distance phone calls, and most of your TV programmes, are routed through one or the other of the satellites? And how often do you give any credit to the meteorologists up here for the fact that weather forecasts are no longer the joke they were to our grandfathers, but are dead accurate ninety-nine per cent of the time?

It was a rugged life, back in the seventies, when I went up to work on the outer stations. They were being rushed into operation to open up the millions of new TV and radio circuits which would be available as soon as we had transmitters out in space that could beam programmes to anywhere on the globe.

### 22,000 MILES UP

The first artificial satellites had been very close to Earth, but the three stations forming the great triangle of the Relay Chain had to be twenty-two thousand miles up, spaced equally around the equator. At this altitude—and at no other—they would take exactly a day to go around their orbit, and so would stay poised forever over the same spot on the turning Earth.

In my time I've worked on all three of the stations, but my first tour of duty was aboard Relay Two. That's almost exactly over Entebbe, Uganda, and provides service for Europe, Africa, and most of Asia. Today it's a huge structure hundreds of yards across, beaming thousands of simultaneous programmes down to the hemisphere beneath it as it carries the radio traffic of half the world. But when I saw it for the first time from the port of the ferry rocket that carried me up to orbit, it looked like a junk pile adrift in space. Prefabricated parts were floating

around in hopeless confusion, and it seemed impossible that any order could ever emerge from this chaos.

Accommodation for the technical staff and assembling crews was primitive, consisting of a few unserviceable ferry rockets that had been stripped of everything except air purifiers. "The Hulks," we christened them; each man had just enough room for himself and a couple of cubic feet of personal belongings. There was a fine irony in the fact that we were living in the midst of infinite space—and hadn't room to swing a cat.

### SHOWERBATH

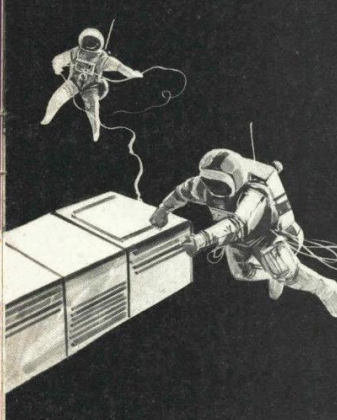
It was a great day when we heard that the first pressurized living quarters were on their way up to us—complete with needle-jet shower baths that would operate even here, where water—like everything else—had no weight. Unless you've lived aboard an overcrowded spaceship, you won't appreciate what that meant. We could throw away our damp sponges and feel really clean at last...

Nor were the showers the only luxury promised us. On the way up from Earth was an inflatable lounge spacious enough to hold no fewer than eight people, a micro-film library, a magnetic billiard table, lightweight chess sets, and similar novelties for bored spacemen. The very thought of all these comforts made our cramped life in the Hulks seem quite unendurable, even though we were being paid about a thousand dollars a week to endure it.

Starting from the Second Refueling Zone, two thousand miles above Earth, the eagerly awaited ferry rocket would take about six hours to climb up to us with its precious cargo. I was off duty at the time, and stationed myself at the telescope where I'd spent most of my scanty leisure time. It was impossible to grow tired of exploring the great world hanging there in space beside us; with the highest power of the telescope, one seemed to be only a few miles above the surface. When there were no clouds and the seeing was good, objects the size of a small house were easily visible. I had never been to Africa, but I grew to know it well while I was off duty in Station Two. You may not believe this, but I've often spotted elephants moving across the plains, and the immense herds of zebras and antelopes were easy to see as they flowed back and forth like living tides on the great reservations.

But my favourite spectacle was the dawn coming up over the mountains in the heart of the continent. The

CONTINUED ON NEXT PAGE



The inflatable lounge was spacious enough to hold no fewer than eight people, and contained a magnetic billiards table.



line of sunlight would come sweeping across the Indian Ocean, and the new day would extinguish the tiny, twinkling galaxies of the cities shining in the darkness below me. Long before the sun had reached the lowlands around them, the peaks of Kilimanjaro and Mount Kenya would be blazing in the dawn, brilliant stars still surrounded by the night. As the sun rose higher, the day would march swiftly down their slopes and the valleys would fill with light. Earth would then be at its first quarter, waxing toward full.

## DARKNESS

Twelve hours later, I would see the reverse process as the same mountains caught the last rays of the setting sun. They would blaze for a little while in the narrow belt of twilight; then Earth would spin into darkness, and night would fall upon Africa.

It was not the beauty of the terrestrial globe I was concerned with now. Indeed, I was not even looking at Earth, but at the fierce blue-white star high above the western edge of the planet's disc. The automatic freighter was eclipsed in Earth's shadow; what I was seeing was the incandescent flare of its rockets as they drove it up on its twenty-thousand-mile climb.

I had watched ships ascending to us so often that I knew every stage of their manoeuvre by heart. So when

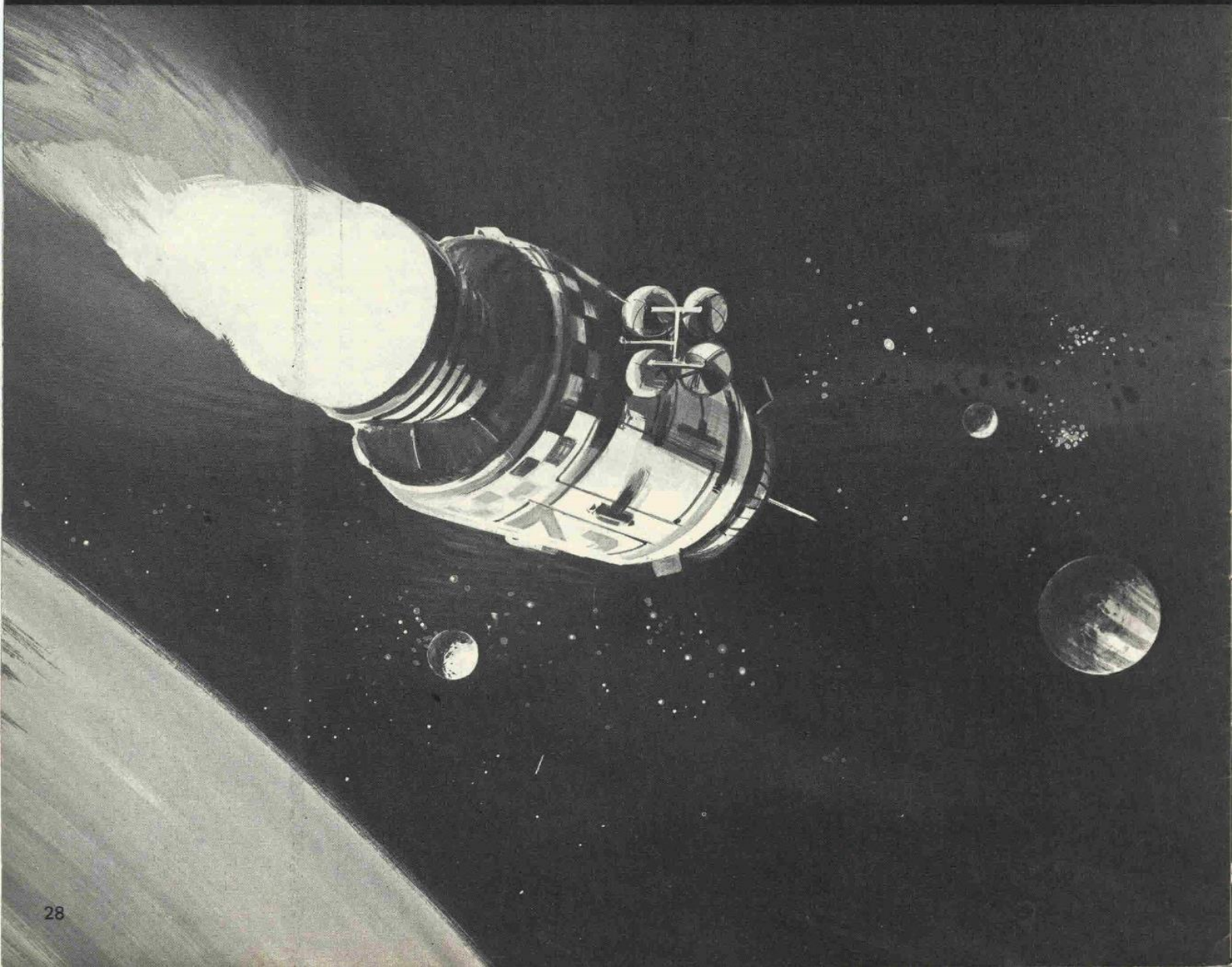


**He knew within seconds that something was wrong. The freighter's auto-pilot had jammed, and there was nothing he could do about it. The ship was moving too fast for Earth's gravity to recapture it . . .**

the rockets didn't wink out, but continued to burn steadily. I knew within seconds that something was wrong. In sick, helpless fury I watched all our longed-for comforts—and, worse still, our mail!—moving faster and faster along the unintended orbit. The freighter's auto-pilot had jammed; had there been a human pilot aboard, he could have overridden the controls and cut the motor, but now all the fuel that should have driven the ferry on its two-way trip was being burned in one continuous blast of power.

By the time the fuel tanks had emptied, and that distant star had flickered and died in the field of my telescope, the tracking stations had confirmed what I already knew. The freighter was moving far too fast for Earth's gravity to recapture it—indeed, it was heading into the cosmic wilderness beyond Pluto . . .

It took a long time for morale to recover, and it only made matters worse when someone in the computing section worked out the future history of our errant freighter. You see, nothing is ever really lost in space. Once you've calculated its orbit, you know where it is until the end of eternity. As we watched our lounge, our library, our games, our mail receding to the far horizons of the solar system, we knew that it would all come back one day, in perfect condition. If we have a ship standing by it will be easy to intercept it the second time it comes around the sun—quite early in the spring of the year A.D. 15,862!





12p Weekly No. 68 July 4-11, 1975

# Speed

## & Power

**RACING  
THE RAPIDS**



**SPECIAL REPORT**  
**We Talk To**  
**JODY**  
**SCHECKTER**

**SHIPS** **SCIENCE FICTION**  
**PLANES** **TRUCKS**  
**TRAINS**



# SEA HUNT

Because our land resources are running out, scientists are turning their attention more and more to the ocean depths in a search for new raw materials.

A STRANGE sight for the late twentieth century, the little red-sailed wooden hulled vessel felt her way through the Antarctic ice bound for her base in South Georgia. Many thousands of miles to the North in the middle of the Indian Ocean, a large white painted ship was hove to, rolling in the long swell, as aboard her scientists took samples from the ocean bed below. Off the Japanese coast a small, fast vessel was steaming up and down leaving deafening explosions in her wake as a survey team searched for oil-bearing strata below. In complete contrast was a silent vessel ghosting over the North Atlantic following a shoal of fish on her instruments and noting their behaviour.

All these ships are part of a growing fleet of oceanographic vessels that are being used to fill in the enormous gaps in our knowledge about the oceans that form more than seven-tenths of the Earth's surface. With resources running out on land man is at last waking up to the fact that much of his future wealth will come from the oceans. Although we have sent rockets out into deep space and have landed men on the moon, our knowledge of this huge area on earth is greatly lacking.

There is almost no area of ocean science that is not greatly inadequate. There is much to learn about the influence of the oceans on climate and such ferocious phenomena as hurricanes. We are pretty good at catching fish with no end of electronic aids to help us, but beyond the ends of the Continental shelves we do not even know what fish there are swimming in the depths. Our knowledge of the minerals that lie beneath the waves is very sketchy, to say the least, although North Sea

oil has given us some indication of the sort of wealth that can be expected. So the hunt for knowledge is on.

The research vessels that are engaged in oceanographic survey work are a very varied fleet, ranging from the little wooden sailing ship *Hero*, that spends eight months in every year in the Antarctic ice working for the United States National Science Foundation to the giant *Akademik* class research ships of the Soviet Union.

## VARIED EQUIPMENT

The equipment of the oceanographic research vessel is as varied as the ships themselves. Some fishery research ships are basically large stern trawlers with laboratories added. These have electric propulsion for silent running, and even the engines are mounted on rubber to minimise vibration that would disturb the fish below.

Some are capable of acting as a mother ship to tiny submersibles that study life in the depths and others are fitted with high speed

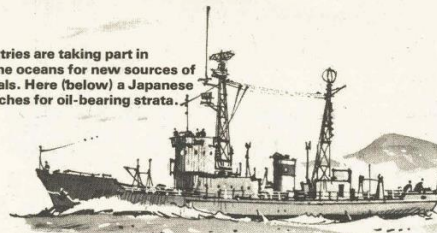
winches that can be used to sample the sea bottom seven miles down in the great abysses. All have considerable laboratory space and a high proportion of scientists of all sorts of specialised knowledge aboard.

Delicate scientific experiments with the ship rolling about cannot be easy and one of the United States Navy's research ships, the *Hayes*, has been built with a catamaran hull to provide a fine steady work platform. This big ship has been built to undertake a variety of types of research, with integral computer facilities and easily changed instrument packages.

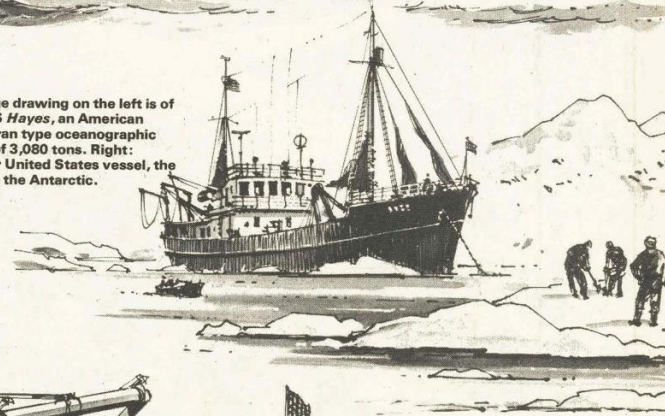
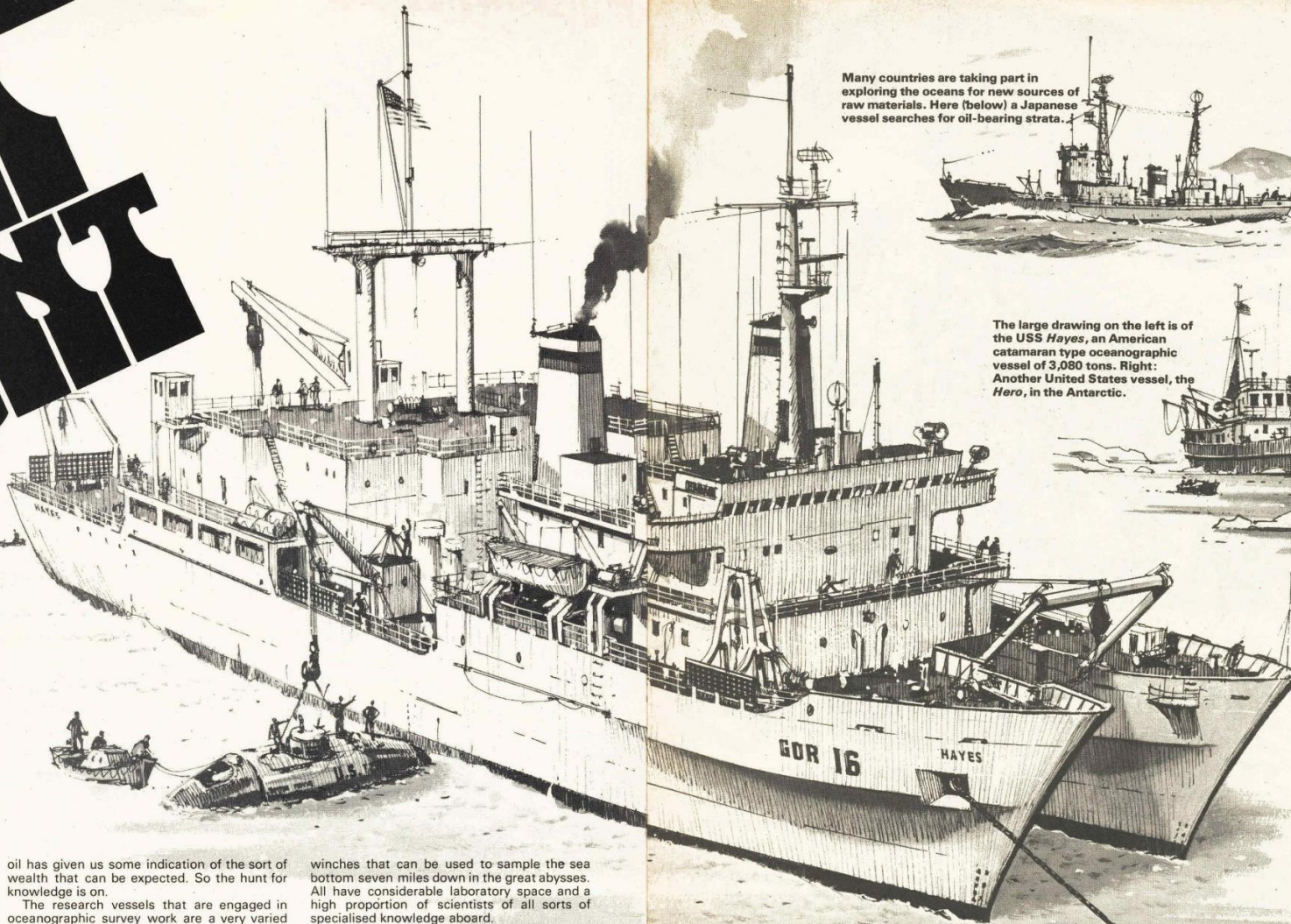
Other American research ships are fitted with a bulbous bow, and in this there is an observation chamber with a good view clear of all the turbulence. Some ships are able to work underwater television and diving bells, explosive core samplers and deep water grabs.

Complicated equipment for adventurous tasks.

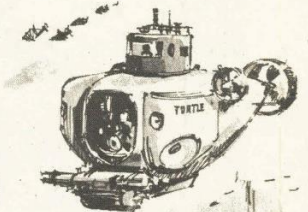
Many countries are taking part in exploring the oceans for new sources of raw materials. Here (below) a Japanese vessel searches for oil-bearing strata.



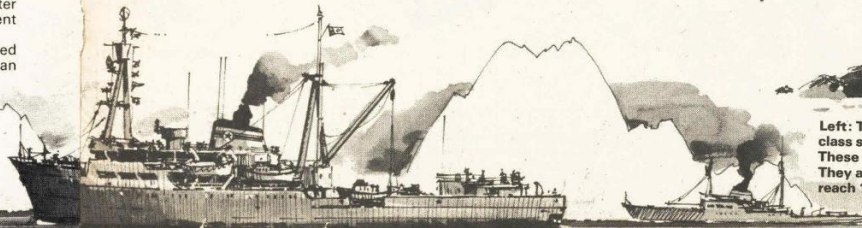
The large drawing on the left is of the USS *Hayes*, an American catamaran type oceanographic vessel of 3,080 tons. Right: Another United States vessel, the *Hero*, in the Antarctic.



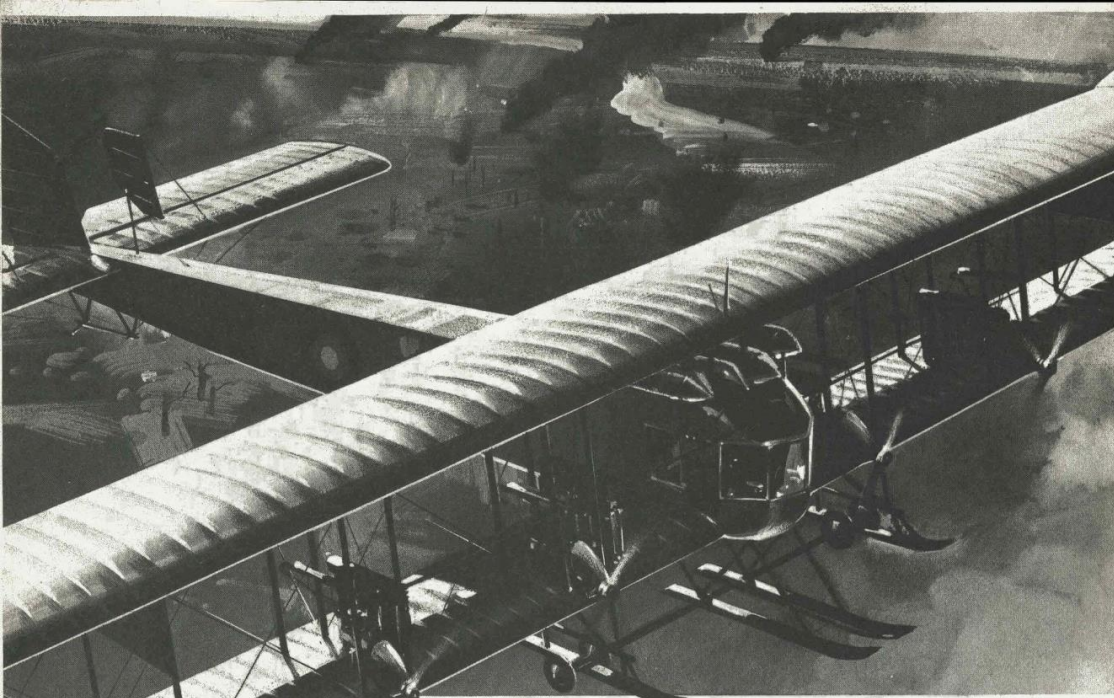
Below: The United States underwater research vehicle *Turtle*. It weighs 21 tons, is 25 ft long and has a speed of 2.5 knots. It can operate for 8 hours at depths down to 6,500ft, and carries a 2-man crew.



Left: Two Russian survey ships of the *Nikolai* class studying icebergs in the North Atlantic. These sturdy vessels have a tonnage of 2,674. They are 295ft long with a beam of 42ft and can reach 16.7 knots. They carry 120 men.

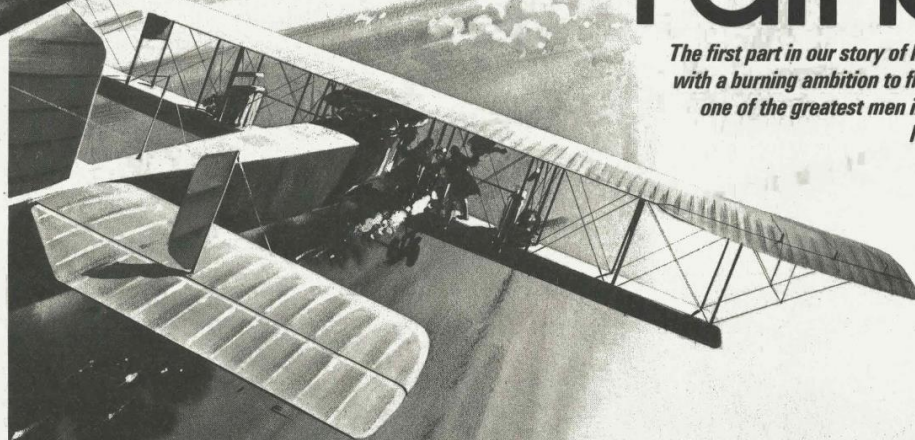






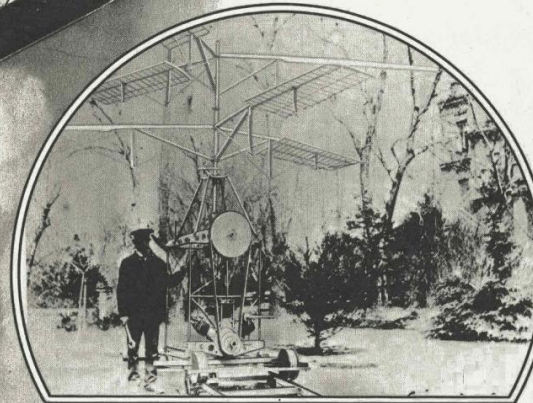
# Father

*The first part in our story of how a boy with a burning ambition to fly became one of the greatest men in aviation history...*



One of Sikorsky's finest planes, the Ilya Mourometz, had a wingspan of 103 feet and set many world records. On one marathon journey, one of the four engines caught fire. Two extremely brave men climbed out onto the wing and battled to put the fire out by smothering it with their coats. Amazingly, they were successful, and the Ilya Mourometz landed in one piece.

Left: Sikorsky built the first four-engined plane, from this followed the Ilya Mourometz which had the luxury of an enclosed cabin for pilots and passengers. Below: The second helicopter built by Sikorsky, completed in 1910.



## The Sikorsky Story Part 1

# of the Helicopter

In the year 1900, a twelve-year-old Russian boy named Igor Ivanovich Sikorsky had a dream. In it, he was walking along a narrow corridor with walnut doors along each side and an attractive carpet, similar to those found on an ocean liner. A blue light illuminated the passage, and he could detect some vibration beneath his feet. This vehicle, however, was not a ship. Igor somehow knew that he was aboard a flying machine, and, as he reached the end of the corridor, the dream ended and he woke up.

Igor Sikorsky had built a model helicopter about a year before this, and he had a firm belief that man would one day fly. While in Germany with his father in the summer of 1908, he learnt of the successful flights of the Wright brothers and determined to make aviation his life.

Seeing the helicopter, with its ability to hover, as the ultimate flying machine, Igor selected this vehicle for his first experiments.

After visiting Paris early in 1909—it was then a scene of intense aviation activity—he returned to Russia with a 25hp Anzani engine and built his helicopter. It was finished in September, and, he recalled, "cost considerable money, made a great deal of noise, had much vibration, and generated great clouds of dust"—but it did not fly.

### POWER PROBLEMS

Undeterred, he built a second helicopter in 1910. Although this did rise from the ground, it could not do so with a pilot aboard, and so Sikorsky turned his attention to his first aeroplane, a small, light, pusher biplane with a 15hp Anzani engine. The S-1, as it was called, taxied well, but being underpowered, made only one brief flight.

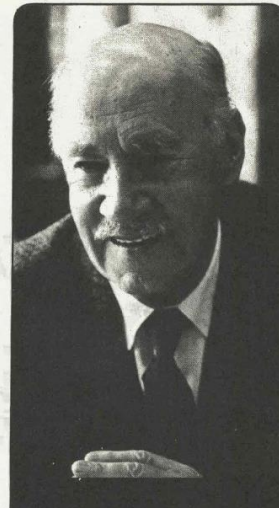
Using the experience—and the wings—from his S-1, Sikorsky then produced the S-2 tractor biplane, installing the 25hp engine from his helicopter. New tail

surfaces were added. On June 3, 1910, Sikorsky's dream began to come true. He took the S-2 on its first, brief flight. Several more followed, until he crashed it due to its low margin of power. The S-3 followed in November. It was similar but larger than its predecessor, and had a 40hp Anzani. This flew quite well, until it was crashed into an ice-covered pond on December 13, on its thirteenth flight.

### PRIZE FLIGHT

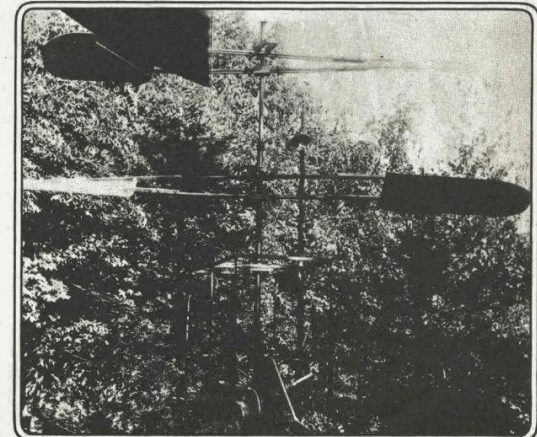
Still the aircraft grew bigger. The S-5, powered by a 50hp Argus motor, at last gave Sikorsky the chance to gain real flying experience, and the S-6A of 1911/12 won the highest award in the 1912 Moscow aircraft exhibition and, in the autumn of the same year, it won its designer first prize in the military competition at Petrograd. During the Spring of 1912 Sikorsky entered into an agreement with the Russian Baltic Railroad Car Factory, becoming the designer and chief engineer of their aircraft factory, and he was authorised to proceed with the construction of the

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Igor Sikorsky in later life. Little did he know that his first comical attempt at building a helicopter in 1909 was the acorn which was to grow and flourish into one of the biggest aircraft companies in the world. A dream come true for Sikorsky.

Below: Sikorsky's first helicopter, built in 1909, vibrated terribly and whipped up clouds of dust—all very spectacular, but unfortunately the machine didn't fly!



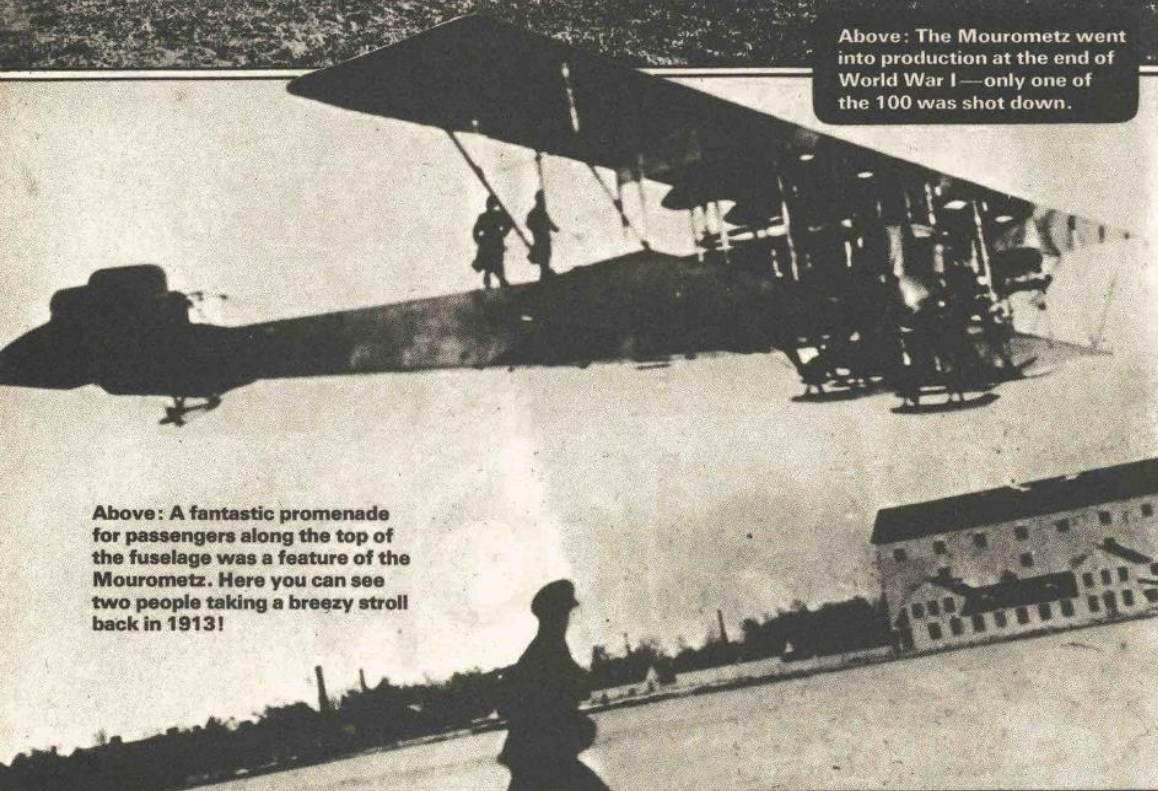


# The Sikorsky Story Part 1

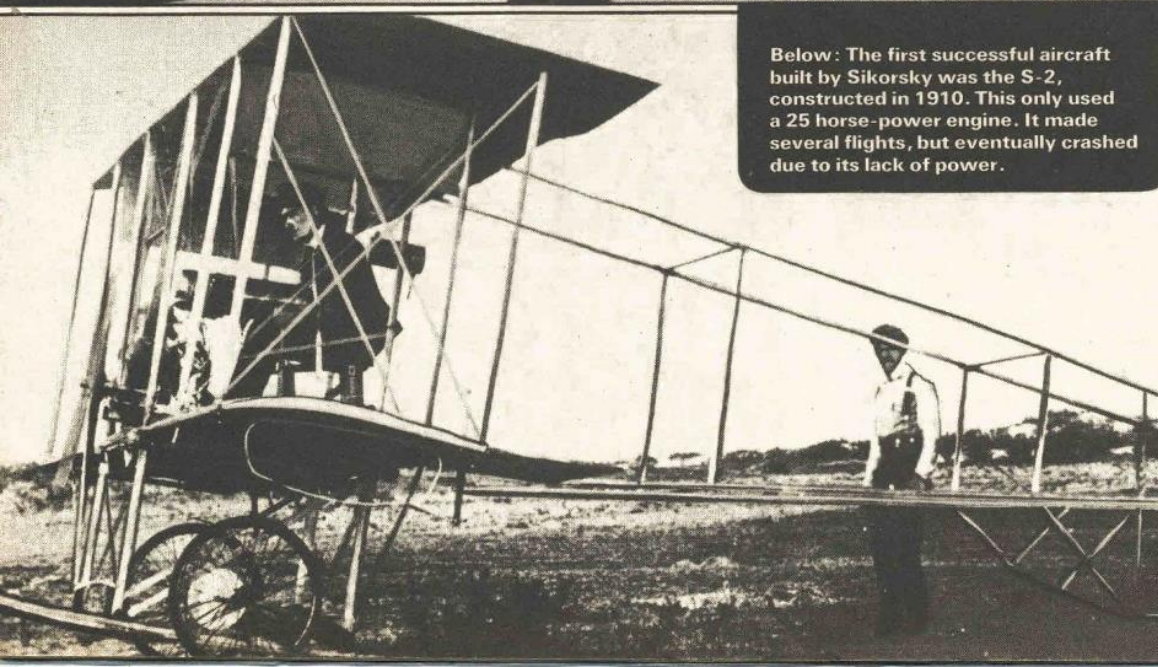
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Above: The Mourometz went into production at the end of World War I—only one of the 100 was shot down.



Above: A fantastic promenade for passengers along the top of the fuselage was a feature of the Mourometz. Here you can see two people taking a breezy stroll back in 1913!



Below: The first successful aircraft built by Sikorsky was the S-2, constructed in 1910. This only used a 25 horse-power engine. It made several flights, but eventually crashed due to its lack of power.

world's first four-engined aircraft.

Such an ambitious undertaking was regarded with much pessimism, but on the evening of May 13, 1913, the first successful four-engined aeroplane in history confounded its critics by making its maiden flight. Named the Grand, it featured an enclosed cabin for both pilots and passengers and had a gross weight of four tons. In its four-month life span the Grand made 55 flights, and from experience gained with it Sikorsky built the *Ilya Mourometz*, even larger and more successful.

Spanning 103ft, more than a World War II Lancaster bomber, this flew in January 1914 and soon established several world records, carrying sixteen passengers on one occasion and remaining aloft for 6½ hours on another. It also survived an engine fire in mid-air, the blaze being extinguished by two men climbing out along the wings and beating out the flames with their coats. An unusual feature of the aircraft was the open "promenade" on top of the fuselage, where passengers could walk during flight!

When World War I broke out, the *Ilya Mourometz* was ordered into production as a heavy bomber, and continual improvements were made. Over 100 of the type were built, and they featured a rather lonely and exposed tail gunner's position. Only one was shot down in action, and they earned a reputation for their ability to take punishment.

Following the 1917 Communist revolution in Russia, Sikorsky emigrated to France, where he worked briefly on the design of a bomber for that country. However, the end of the war stopped the project, and he then sailed for America.



12p Weekly No. 71 July 25–August 1, 1975

# Speed & Power

PLANES SHIPS CARS  
SCIENCE FICTION  
SPACE

BATTLEFIELD  
TASKFORCE  
GREAT NEW SERIES



# SCHOOL FOR SKIPPERS

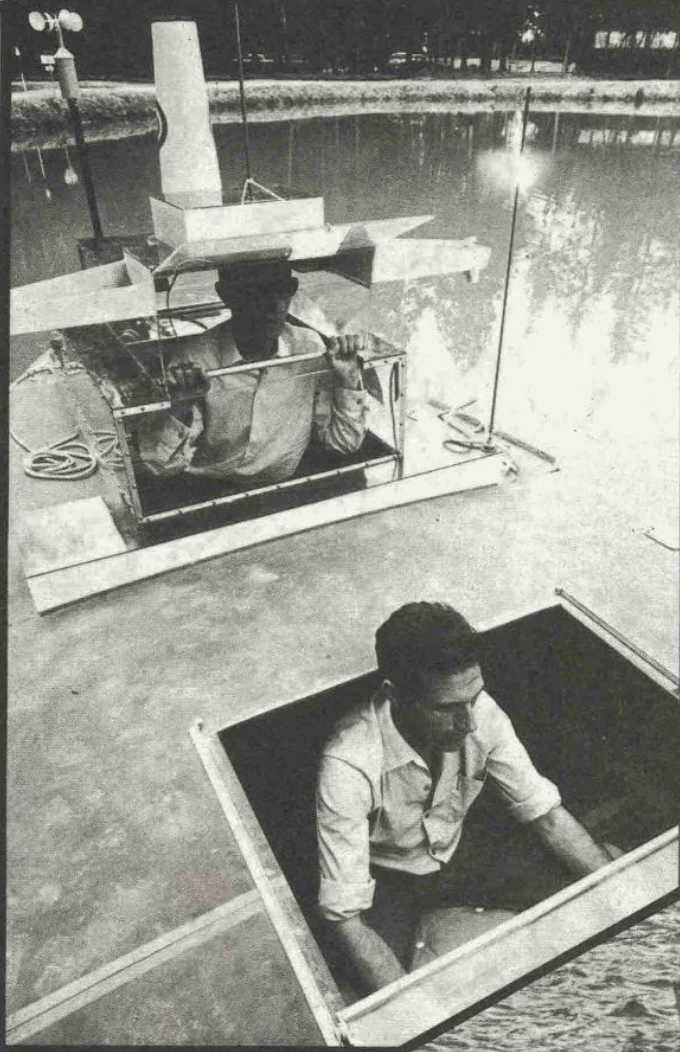
Being the captain of a giant oil tanker is one of the most responsible jobs in the world. But many of the skills are taught in cinema-like classrooms and model boats!

**S**TANDING in the wheelhouse of the 300,000 ton tanker, the captain watched the lights of the buoyed channel into the port draw slowly closer. Above the noise of the bridge machinery and the whine of the following wind, he heard the navigator's voice clearly announcing the range of land as he read it off the radar, and out of the corner of his eye he kept a close watch on the electronic depth indicator, watching the fast diminishing depth of water under the keel.

The port entrance was a tricky one for all ships, involving a rapid turn to starboard between two shoals at the harbour mouth. At his command was one of the biggest ships in the world, so the captain knew there was little room for error. He wondered whether to call off his approach and wait for daylight, but the wind from astern was increasing and there was no anchorage available which would give shelter to the vast draught of the mammoth tanker. Besides, if he did not get alongside before the weather broke the tugs would find it impossible to push against the wind and tide, which would shove the ship back into mid-stream.

## GREAT WORRY

Trying not to let his voice betray the worry he felt, the captain ordered the engines to drop another ten revs. He saw through the wheelhouse windows the lights of another vessel approaching up the channel and mentally cursed the port authorities whose duty it was to keep the narrow entrance clear for his approach. To his con-



Above: Esso's tanker captain training centre in France operates several model tankers which handle in exactly the same way as the real ships. Here a trainee is watched by an instructor on board. Right: Artificial waves are created to make things tougher for the "pupils".

Photos: courtesy Esso

sternation he saw that the other ship was closing fast and evidently did not intend to alter course. The captain leapt to the engine control, simultaneously calling for the helmsman to alter course to starboard.

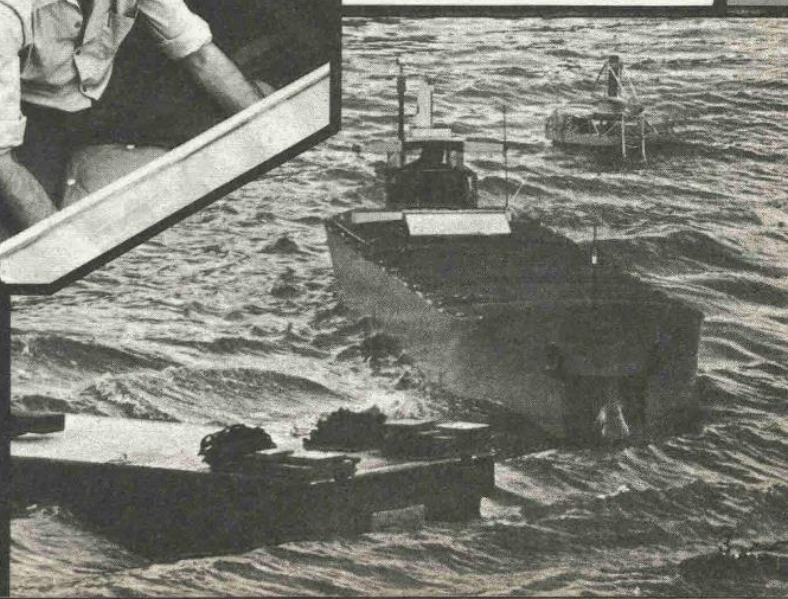
With the hairs beginning to stand out on the back of his neck he watched and waited for the slow swing of the bow 800 feet ahead, to start. In the centre of the console before him a light suddenly glowed bright red and the harsh sound of an alarm klaxon rang out loudly within the close confines of the wheelhouse. *The steering had failed!* Out of control the giant ship lurched on, swinging wildly toward the harbour mouth and the "rogue" vessel coming out.

## SHIPWRECK!

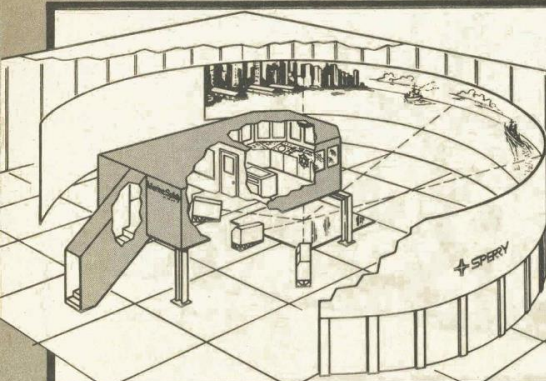
This "incident" was not the run-up to the shipwreck of the century, but a dry-land exercise in ship-handling on the latest navigational simulator, an instrument designed to help ship's captains get to know their vessel's characteristics before they ever step aboard.

The biggest and fastest ships

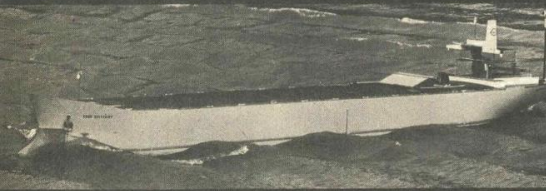
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Above: A diagram of the "simulator" which can make a trainee captain feel just as though he is on the bridge of a massive tanker in terrible conditions. Linked to a computer, projectors throw a wide-angle picture of what is happening on to a screen.  
Below: Artificial waves make the going difficult for a model tanker at the French training centre.



## SCHOOL FOR SKIPPERS

CONTINUED

at sea today are so very different from those that have been built before that a course on a simulator is considered essential when a master is moving from one type of ship to another. The middle of

the night in the English Channel is the last place to find out about your ship's handling characteristics, while a half-million ton tanker is far too valuable a beast to borrow for an afternoon's "drive" just to get the feel of it. So the simulator is the answer.

The best, and most important feature of a simulator is that it enables a wide variety of disasters to be inflicted upon the poor captain undergoing instruction, so that his reactions can, to some extent, be programmed to get him out of trouble. Our steering

gear failure, for instance is a very rare occurrence indeed, and there are many experienced seamen at sea today who have never had this happen to them.

It is a very different thing from reading about such happenings in a textbook and actually experiencing them. All ships behave differently in different wind and sea conditions and the simulator is able to reproduce all of these so that practice will indeed make perfect. And if the instructor is doing his job properly,

the captain will soon forget that he is on land in a brick-built classroom, and will mentally be aboard his ship solving problems.

The important thing that a simulator must be able to supply is that of realism. With simulators that do not attempt to reproduce a full visual picture this realism is easy to attain. A computer-driven radar picture in a darkened chartroom with instruments all working and the hum of distant machinery is enough to provide very authentic circumstances to

an anti-collision exercise played on the radar.

In one college it used to be a tradition that after the course had finished, the instructor programmed the computer so that whatever the ship's captain did, he would be sunk, and it was not unusual for these poor masters to come bursting out of the simulator shouting for all hands to abandon ship!

## VERY EXPENSIVE

The most expensive simulators are those that provide complete visual simulation—looking just like the real thing. In these there is a fully fitted ship's bridge, with all the proper instruments really working. Looking out of the wheelhouse windows there will be a view of the ship's foredeck and a sea horizon. Into this picture can be introduced other ships, coastlines, rocks, buoys and shoals, and the "own ship" will behave perfectly authentically in relation to her size. This picture may be provided from a projector on to a semi-circular screen, or even transmitted from a small scale model with a tiny camera. Once again, the computer is a valuable tool in making the picture look real and the action authentic.

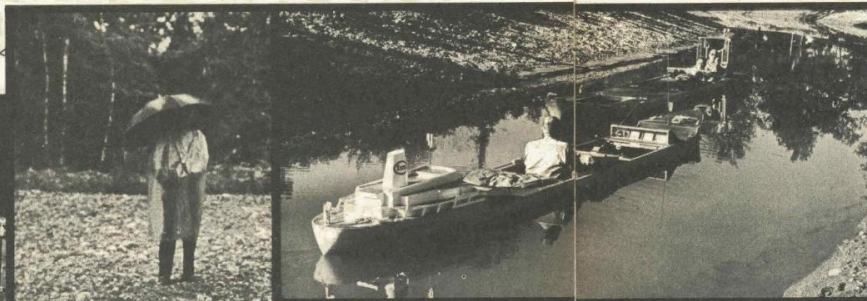
The instructor takes great pains to keep the climate on the "bridge" as realistic as possible.

There will be taped noises of wind and sea and if the ultimate in realism is required, there will be the inevitable mugs of cocoa to drink. Indeed, in one simulator designed for training navigators of warships, the whole bridge rocks around like a small ship in a heavy sea and high pressure hoses spray it with tons of water!

A completely different simulator is the ship-handling trainer at the Esso Marine Research and Training Centre, Port Revel in France, a boy's dream in which model ships about twenty feet long are used to reproduce ship handling problems on a lake. Crouching on a little seat in the bottom of the model supertanker the captain sits, working his miniature controls and feeling at first as if he were a lad again.

The ship behaves exactly as his destined command will handle—if the ship takes ten minutes to turn right around then the model will do the same. In a narrow channel, mooring to a buoy, in collision avoidance exercises, the model will behave authentically, and the captain will end each exercise cramped but impressed. And there is no doubt that if the steering gear does break down at the harbour entrance with another ship bearing down on him, the captain, thanks to the simulator, will know exactly what to do.

Left: Messing about on the river—seventies style! Two 1/40 scale tankers pass in a miniature version of the Suez canal at the training centre.  
Below left: Some full size rain presents large scale problems for trainee captains! Due to the absence of sou'westers, umbrellas make a good second best and the mini-fleet carries on. Sitting in front of their little control panels, pupils control their ships in the same way as the real thing.



Below: This is not the sort of scene you see on the great shipping lanes of the world, but it's the start of something big for would-be captains. Rain is a problem you face when sailing any kind of ship, so you have to hoist the umbrellas and batten-down the plastic mags!





Left: One of the many swing wing designs that did not fly was the Fokker-Republic Alliance. Narrow auxiliary wings folded out over a fixed delta. Above: Boeing's idea for a swing-wing supersonic airliner.



Above: The first modern European swing-wing military aircraft to fly was the Mirage G8 from France.

Right: The RAF would get its first MRCA Tornados in 1978. 1—In a zoom climb, the wings go fully back. 2—In air superiority role, the aircraft "loiters" high up with wings spread. 3—Down on the deck with wings back for low-level attack.

WHEN THE first USAF F-111s arrowed across the skies of Nevada in 1967 the era of modern swing-wing flying was born. This exciting aircraft, and the research planes that flew before it, enabled American engineers to draw up designs for combat aircraft of the future—super machines like the F-14 Tomcat and Rockwell B-1 bomber.

But, even though the Americans were the first to get airborne on moving wings, on the other side of the world, Russian scientists had also seen the advantages these aircraft offered.

Great Britain, Italy and Germany have developed the Multi-Role Combat Aircraft for all three countries' air forces in two years or so. France also has her

own Mirage swing-wing fighter flying on tests.

But if swing-wings are all "go" for the 1970s, and '80s, the idea has been quite a time coming. After the early post war efforts (described last week), not much happened, at least in the West, until 1959 when the F-111 design was ordered by the US Air Force.

It has often happened in the aviation world that engineers in different countries see a good idea at much the same time. So

it was that swing-wings for modern combat aircraft came to the attention of the Russians about the same time as in America.

Since 1965, at least six types of swing-wing military aircraft have flown in the Soviet Union and two have gone into service as very effective multi-role fighter/bombers.

One of these is the Mikoyan MiG-23 series, which is slightly smaller than the F-111 and has much the same wing and tail shape. The single-seat MiG-23

joined the Red Air Force in 1970, and is powered by a single large engine to give it very high speed. How well the Russians have met the challenge of moving wings in flight is shown by the fact that the MiG-23 is one of the most advanced combat aircraft in Russia, if not the world, today.

Other swing-wing designs have come from the Sukhoi design Bureau, including an Su-7B development and the more advanced Su-20. These nimble fighters have large fixed wing



The mighty F-14 Tomcat is the first swing-wing Navy aircraft in service.

1—Approaching the carrier with everything "out and down"—wings fully forward. 2—At altitude, the F-14 swings its wings back to fire Phoenix missiles. 3—For a slow air combat turn, the Tomcat's wings can be set at half sweep.

Above: The single seat version of the Soviet MiG-23 is known to the West by the code-name "Flogger". Smaller than the US F-111 or F-14, it has a single engine which gives a speed of about 1,650mph.

centre sections and slender swinging outer wings.

After the F-111, the next swing-wing aeroplane to fly in the West was France's Dassault Mirage G8 aircraft, in 1971 and '72. These machines have carried out much research flying but, as yet, France has not developed her own swing-wing combat aircraft.

Meanwhile in the USA, Grumman, the firm that built the Jaguar experimental swing-wing US Navy fighter, completed the

superb F-14 Tomcat for its first flight in December 1970. Today, over 100 of these versatile and formidable fighter-attack planes are in service with the US Navy, each costing a cool 20 million dollars!

After the RAF decided that the F-111 would be too costly to buy, the gap that would have been filled by it was still there. It was plugged by supplies of Phantoms from America, but by the 1980s, a new aircraft would be needed. So Britain, Italy and Germany decided

to pool their efforts to design a European swing-wing aircraft they could all use.

That aircraft is of course the MRCA—Multi-Role Combat Aircraft—which will be called "Tornado" in service. Designing an aircraft to do many jobs can be difficult, but the flight rests with MRCA have shown that it can be done—and done very well!

All the swing-wings we have mentioned so far are in the smaller fighter/bomber category, but the idea has been applied to

larger aircraft, too. In the United States, the Rockwell B-1 bomber is intended to replace the old B-52 Stratofortress in Strategic Air Command—America's nuclear attack spearhead, should war come.

The Rockwell B-1 first tested its wings on December 23, 1974. It carries a crew of four, tons of highly complex electronic "black boxes" and as much fuel and bombs as a whole squadron of the earlier bombers that it will replace.

But the Russians have also seen the way to have a long-range

CONTINUED ON NEXT PAGE



# Swinging Rivals



Wing extended,  
screwjack  
retracted

Wing swept,  
screwjack extended

Wing sweep  
screwjack

Screwjack  
hydraulic drive

Double titanium  
(fail-safe) wing pivot

**Above:**  
The Russian answer  
to long-range penetration  
by manned aircraft is the Tupolev  
"Backfire" (all Russian aircraft are still  
given code-names), but little is known  
about it in the West yet.

**Above:** The first Rockwell B-1 lifts off on its maiden flight late last year. On order for the US Air Force the B-1 is going to cost some 50 million dollars apiece, so the numbers may have to be cut back. But a new bomber is long overdue in the USAF.

## Swinging Rivals

CONTINUED

aircraft with swing wings. Their answer is the secret aircraft we know simply by the code-name "Backfire". This remarkable plane does not even have an official title that we know of. As far as our experts know, it is about twice as heavy as the F-111, tipping the scales at about 100 tons. Like the B-1, it can fly inter-continental bombing missions and has swinging outer wing panels, outboard of a large fixed centre section. It is believed by Western intelligence experts to have a speed of at least Mach 2.5—two-and-a-half times the speed of sound!

On the passenger-carrying side,

there has not been much practical progress towards an American swing-wing supersonic transport (SST), but if they ever build one it is thought that the designers will go for a moving wing layout.

One thing is certain: swing-wing aircraft are here to stay. And combat pilots are very grateful for the extra ability that the designers have been able to build into their aircraft.

A swing-wing is not only very economical on fuel for long range ferry flights when, for example, it is staging to a forward base for operations near the front line, but it has excellent "loiter" ability. This comes into its own when an aircraft is used in the air defence role or delayed ground attack.

A situation might develop where a front line commander wants swing-wing aircraft to make an attack on a target, but must wait for the enemy to get into an

ideal position. In a rapidly-changing battlefield situation, it is better to have fully-armed aircraft in the sky ready to pounce with their weapons loaded, than have to wait to call up grounded aircraft and maybe miss the chance to make an effective target "kill".

Also, when the time for the attack comes, a swing-wing plane tends to have a higher wing "loading", than ordinary aircraft, which means that it can carry more weapons. And when the swing-wing pilots get their orders, they can sweep the wings back and dive very fast, level off and

**The mighty B-1 makes its first flight. The aircraft will be a main element in the USAF's future defence plans.**

use their terrain-following radar to zoom in under cover and plaster the target.

Naturally, a conventional jet fighter can do all this, but it would use much more fuel in the process. And the pilot certainly notices the difference when the swing-wing is near the ground. A conventional aircraft does not like riding through rough air near the Earth's surface and is buffeted about quite severely. But, with a moving wing aircraft, this problem is taken care of and supersonic "dashes" at altitudes of less than 100 feet give the pilot a much smoother ride.

All over the world, aircraft designers are looking now to the planes that will be flying in ten, twenty and even fifty years time.

With all the information they will receive from in-service reports of the F-14s, B-1s and MiGs flying today, any self-respecting air force will, in the years to come, order swing-wing equipment. In fact, this type of aircraft could eventually be as much a forward step in aviation as the monoplane was in the age of the biplanes!

Photo: courtesy Rockwell International



# CAT



Left: Leopard A3 MBT fitted with a welded hollow armour turret, an infra-red searchlight above the 105mm gun for night fighting, a 7.62mm coaxial machine gun (M.G.) alongside the barrel and another M.G. on the turret for anti-aircraft fire. Smoke dischargers are mounted either side of the turret. Fitted with a snorkel the tank can wade through water up to 13 feet deep.

# WITH TEN LIVES

*A tank for all tasks—the German Leopard has many different roles to play on the modern battlefield.*

**W**ALLOWING and bucking across rough country, the 40-ton German Leopard Main Battle Tank (MBT) is a brisk performer with a top speed of 40mph. Its 10-cylinder 830bhp multi-fuel engine gives it a high power-to-weight ratio but there's a drawback. Most modern tank suspension systems, including the Leopard's, just can't cope with that weight and speed and above 30mph the four-man crew are likely to get so battered and bruised that they become unfit to fight!

Since it first appeared in 1965, the Leopard has been made in

four different models, all of them packing the punch of a 105mm gun. Early versions had a rounded cast turret, but the A3 model was fitted with an angular hollow armour turret. Hollow or space armour has an outer skin to explode and absorb the blast of a direct hit and an inner skin to prevent metal splinter ricocheting around the turret and injuring the crew.

A laser beam and computer fire system automatically works

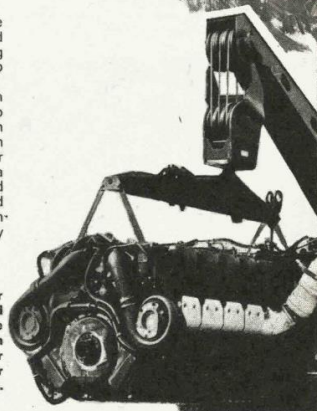
out the type of ammunition, the range and the trajectory needed to make a hit on a target leaving the gunner with little work to do except press the "FIRE" button!

Aside from the variants shown here the Leopard chassis is also used as a Bridgelaying Vehicle, similar to the ARV but fitted with a powered soil borer and a toothed dozer blade for excavating, and as a 155mm self-propelled gun which can hurl a 98lb shell nearly 15 miles.

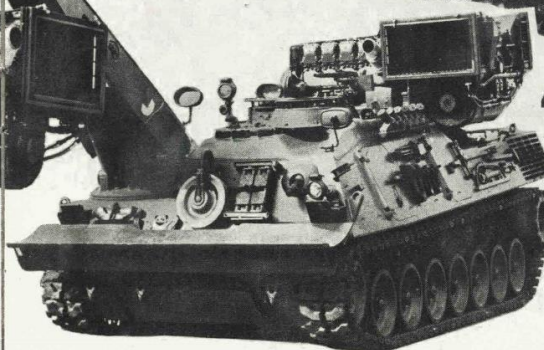
Left: A turret mounted radar scanner which tracks attacking aircraft and automatically aims the guns is a feature of the Flakpanzer mobile anti-aircraft system. The twin 35mm Oerlikon guns can be fired in single, short or continuous bursts with a rate of fire of 550 rounds per minute.



For rescuing crippled tanks from a battlefield and for frontline maintenance, this Leopard Armoured Recovery Vehicle (ARV) has a 34-ton capacity winch carrying 330 feet of steel cable and a hydraulic lift jib with a capacity of 19 tons. Pulleys, shackles, bolt cutters, wrenches, an axe, spade and spare tracks are clipped to the superstructure. Armament consists of smoke dischargers, a turret and a bow M.G. The ARV shown here is lifting a Leopard MBT engine and is carrying a spare one on its rear deck.



Below: The crew of an ARV use the crane to clear away debris as they prepare to haul a stranded Leopard MBT out of a ditch.



Above: Fitted with a "greenhouse" cupola to give good all-round vision this special version is used to train tank drivers. Like the MBT, this Leopard chassis carries a maximum of 238 gallons of fuel which gives it a road range of nearly 400 miles and an across country range of 260 miles.

GREAT  
NEW SERIES  
**ARMOUR  
AT WORK**





**INSIDE  
STORY**

# *Walking around* **A GENTLE GIANT** *McDonnell Douglas DC-10*

*"Good neighbor airplane", "whispering giant" and "lion with laryngitis" have all been used to praise the powerful, clean DC-10 airliner. Last week it took us on a holiday flight to Venice—now we take a closer look beneath the skin . . .*

**S**TANDING in the spectators' lounge at London's Gatwick Airport, you watch as the big wide-body passenger jet starts to accelerate down the runway. You note the position of its three engines, the rake of its wings, its undercarriage, and you

recognise it as a McDonnell Douglas DC-10.

As the giant aeroplane sprints across the concrete and lifts majestically into the air there's something strange about it, you feel. It's the noise—or lack of it. When 200 tons of metal, people

and baggage lift off the ground you expect there to be an ear-splitting roar, with great plumes of smoke announcing the tremendous display of power.

Instead, there's scarcely more than a polite hum and a whoosh. And not even a whisper of smoke, for the DC-10's engines—three General Electric CF-6s—are clean as well as quiet.

But come aboard and have a walk around! After all, there's plenty of space—the passenger cabin is no less than 18 feet 9 inches wide. Pace that out—and you'll be surprised how wide it is. And never fear about bump-

ing your head as you walk to your seat—the ceiling is 8 feet high, about as high as the ceilings in most modern houses!

From stem to stern the DC-10 is about 182 feet long—182 feet of steel, and alloy, and plastics, and seat padding, and wires and rods . . .

No one has thought of a better way of building aeroplanes than on a production line—a bit like making motor cars—only aircraft are far more complicated than cars, especially giant airliners.

Take a careful look at the

**CONTINUED ON NEXT PAGE**



photos of DC-10s being built at the massive McDonnell Douglas factory in California. You will notice that the working platforms are on wheels, enabling them to be moved as the airliner gradually takes shape and is rolled to the finishing shop. At this stage most of the aircraft has a bottle-green colour—a sign that an anti-corrosion solution has been applied before the airline's colour is painted on.

In addition to the engines

(themselves made up of hundreds of parts), there are 210,000 parts in a DC-10. About one-and-a-quarter million rivets help to keep all the bits together but another half-a-million fasteners of various sorts are used as well.

Between 40 and 50 MILES of electrical wire go into each DC-10 and the power produced by the generators is enough to keep 170 homes going!

A DC-10 Series 30 in Lufthansa colours, showing the centrebody undercarriage which it and the Series 40 have because they are heavier and have a wider wingspan than the Laker-type Series 10s.

## GENTLE GIANT

CONTINUED

Left: These American executives are dwarfed by the massive CF-6 engine, one of three that power the DC-10 skywards. The engine, first test-flown attached to the giant US Air Force B-52 Stratofortress bomber, was the first of the giant civil turbofans, based on the TF39 which powers the world's biggest aeroplane—the Lockheed Galaxy.

Left, centre: Every new aircraft design has to undergo wind tunnel testing to arrive at the most economical and safe shape. In fact, the DC-10's design goes back as far as 1966, although manufacture wasn't started until 1969 and the first flight not until 1970. First scheduled passenger flight (DC-10 Series 10) was on August 5, 1971.

Below: Two views of the massive assembly line needed for a plane the size of the DC-10. The building is 1,148 feet long, and in here the wings and fuselage sections are joined during final assembly. Apart from engine components, there are 210,000 parts to the DC-10, and holding the airframe together are 1,750,000 rivets, bolts and screws. The bottle-green colour you can see on the fuselage, wings and engine surround is the anti-corrosion liquid applied before the airline's colours have been painted on.

As you can imagine, the painting of a DC-10 is a very big job—and it has to be done properly—it wouldn't do for the aircraft to look scruffy!

Anyway, now we're aboard, let's give the airliner a good look-over. We showed you the flight deck last week, so out through the crew door we walk into the cabin and see those 340-odd seats. When the plane takes off or is about to land, passengers in the front few may feel a slight "clunk"

This brings us about amidships where the massive 165ft. 4in. wing bears the great jet aloft. To help the DC-10 get off the runway quickly and climb steeply, there are slats (9) on the front of the wing and flaps (10) at the back. To tilt the great aircraft to right or left, the pilot moves the ailerons (11 and 15) which are situated near the flaps. Spoilers (18) are sometimes used to help the ailerons, or more usually to slow the aircraft as it nears the end of its journey.

If you are sitting by a window overlooking the wing, you will notice the flaps, spoilers, slats and ailerons doing their job during various stages of the journey. You have to be quick to see them, though, because sometimes only a slight movement of the controls is enough to tilt the wings and make the plane bank to left or right.

By the way, when the plane is airborne you will probably notice the wing flexing—it's nothing to worry about. On the contrary, if the wing was rigid and didn't move it would probably shake the airliner to bits!

Two of the great General Electric CF-6 engines hang beneath the wing—and most of the fuel serving those engines is carried in the wing—the DC-10 Series 10 (like Laker's) can carry 18,151 Imperial gallons—enough to run the average family car over 22 times round the Equator!

Like the galley, the baggage is stowed in holds under the floor (19) where there is plenty of room for your holiday luggage. At both ends of the cabin, the "powder rooms" (2) are situated; small, but well equipped, there's even a plug for dad's electric shaver.

We have come to the end of the cabin—but not the end of the fuselage. The next interesting item you should know about is the (APU) Auxiliary Power Unit (24). This is really a mini-jet engine which provides power to start the three CF-6s.

Overshadowing the APU is the great rudder (20) which does just the same job as a rudder on a ship—it helps to point the mighty jet in the right direction. The other part of the tail, the elevators (21), act in the same way, tipping the plane up or down—or just keeping the airliner on an even keel.

So we have arrived at the "stern" of this big "ship" and hope that when you take a flight our explanation will help you to know what is going on. Perhaps your knowledge will help to reassure any nervous passengers who are not so well-informed as you are! Happy holiday.

under their feet—for the nose-wheel (6) is underneath (and behind the captain, you will notice, so he has to be very careful when steering). The cabin itself is divided into sections so that passengers don't get the feeling that they are in a tunnel.

Behind the nose-wheel is the underfloor galley (5) in which all the meals are made ready for serving.

### Key to DC-10 (Series 30)

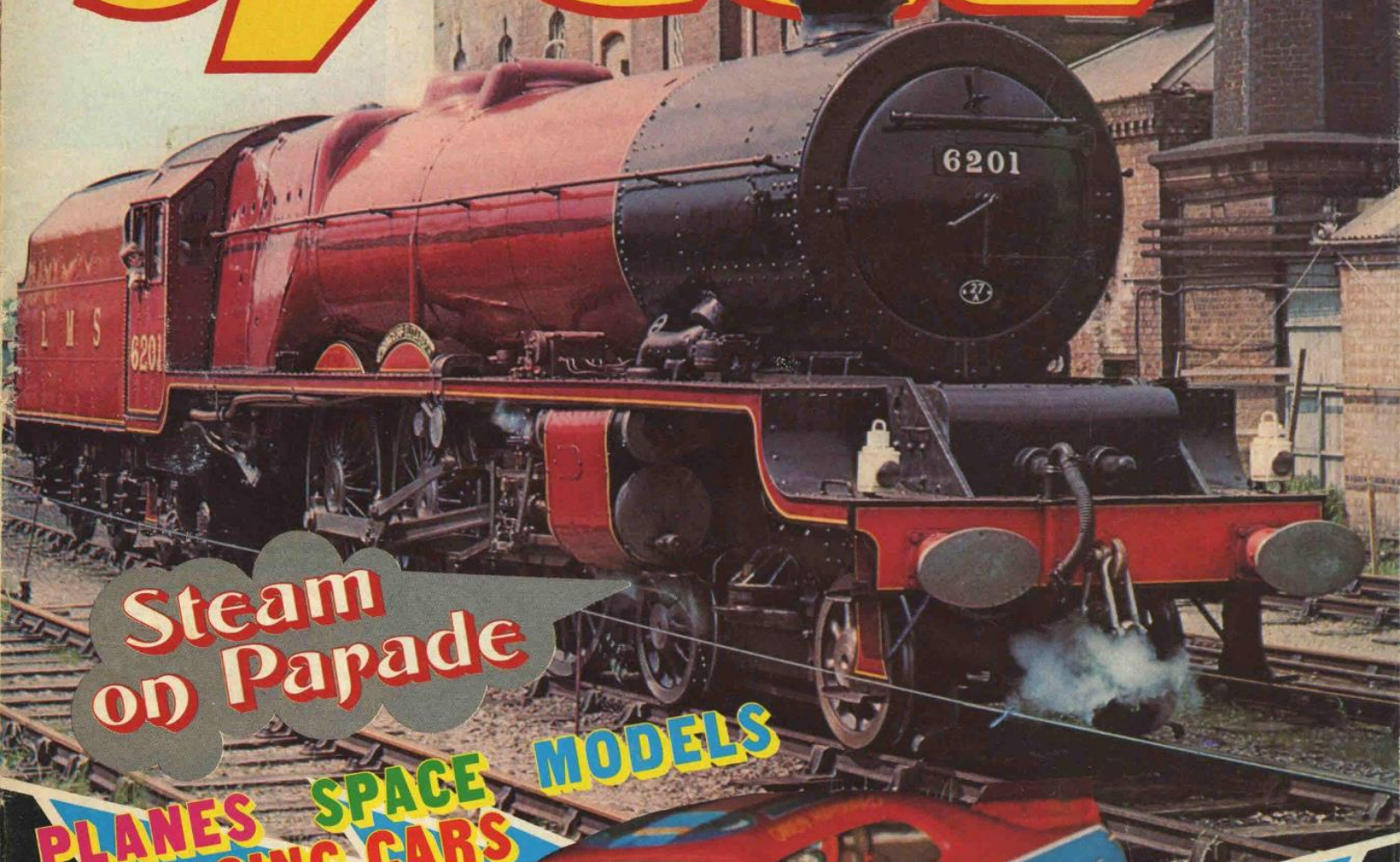
1—Weather radar. 2—Toilets. 3—Seating, which can be varied according to duration of flight regularly operated by an airline. 4—Passenger entrance doors. 5—Galley beneath passenger cabin, with service lifts. 6—Nose-wheel beneath front passengers' seats. 7—Forward cargo hold with containers. 8—Three General Electric CF-6-10 turbofan engines. 9—Leading edge slats. 10—Double-slotted flaps. 11—Inner Ailerons. 12—Main wing fuel tank. 13—Main wing undercarriage. 14—Centrebody undercarriage. 15—Outer ailerons. 16—Navigation light. 17—Overhead luggage lockers. 18—Spoilers. 19—Bulk cargo hold door. 20—Double hinged rudder. 21—Tailplane. 22—Elevator (two pieces per side). 23—Maintenance entry. 24—Auxiliary power unit.

Photos: courtesy McDonnell Douglas; Lufthansa



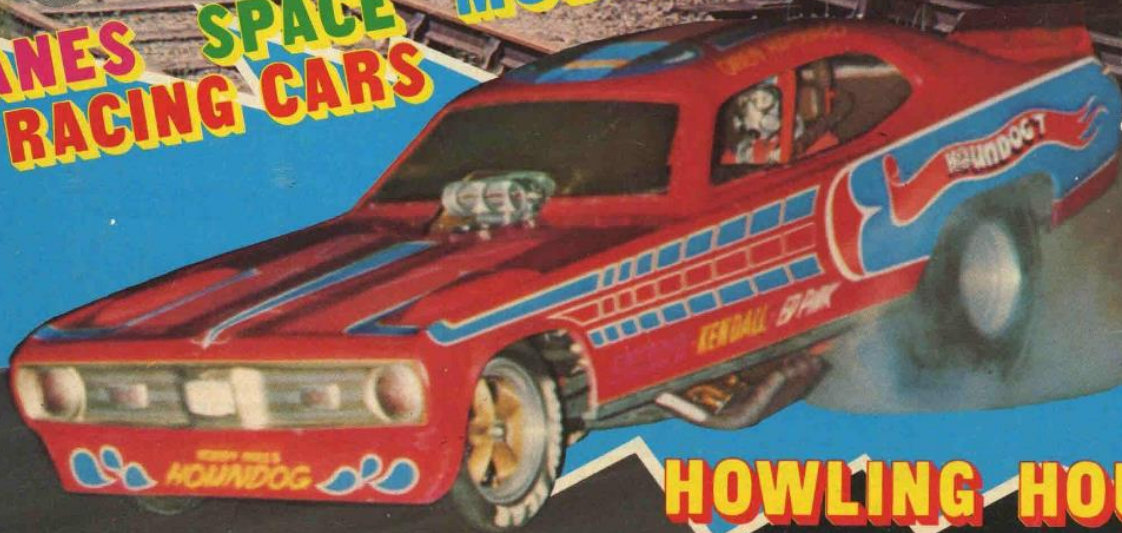
12p Weekly No. 74 August 15-22, 1975

# Speed & Power



Steam  
on Parade

PLANES SPACE MODELS  
RACING CARS



HOWLING HOUND



WITH a wingspan greater than six wartime Spitfires or one C-5A Galaxy, a tail that would tower over the RAF's mighty Vulcan bomber and a fuselage longer than a modern Nimrod, the Convair B-36 bomber of 1946 was one of the world's biggest-ever aeroplanes. It was so big that there was a miniature train for the crew to move about inside and the machine was even going to carry its own fighter protection on bombing missions!

When the dust of WWII settled in 1945, the world fell into a state of uneasy peace—uneasy because most people saw that the weapons that had just finished one war could so easily start another. The atom bombs dropped on two Japanese cities had changed war for good; if just one aircraft could wipe out a whole city, what of the future?

So it was that the great powers began a policy of making sure that each would be as strong as his neighbour, that their weapons would be so terrible that an enemy wouldn't dare attack. And that's where the B-36 came in.

## ATTACK THREAT

The United States soon realised that a future threat could come from the ever-expanding Communist powers—Russia, China and their allies. So, the bomber with a hope of reaching targets in those countries would have to have range—*huge* range. The B-36, the last version of which weighed a colossal 183 tons bombed-up, was designed to attack any industrial centre within 4,000 miles of a US airbase—virtually any point on the globe.

The fact that the B-36 was primarily powered by piston, rather than jet engines (although later models of the bomber had jets to boost speed in short bursts) was because it was first thought of as far back as 1940. In those days, to get range from the engines of the day, you had to have almost as many motors as rivets to hold the aircraft together! The B-36 was planned when it looked like the British Isles would fall to a German invasion; the war may have had to be fought from America, and bombers had a long way to fly to targets in Europe.

The first XB-36 flew on August 8, 1946 from the Convair plant aerodrome in Fort Worth, Texas. It was probably fitting that such a monster of the skies was built in the US State where everything is said to be the biggest!

The silver giant was staggering to the imagination. The wings

Everything is said to be big in the US State of Texas and just after WWII, one of the biggest planes ever was born there. As one pilot said of it, "It's like standing in the bay window and flying your house!"

# BOMBER BUILT FOR PEACE

carrying a fighter in its belly!

stretched away from each side of the fuselage for no less than 115 feet—230 feet overall. They would lift the aircraft to 45,000ft. and carry men, fuel, bombs and equipment for nearly 8,000 miles.

Inside, the B-36 was even more impressive. Up front was the first of two pressurised compartments, containing the flight deck and seats for two pilots, radar-bombardier, navigator, flight engineer, two radiomen and three gunners. To reach the second cell, with room for five gunners,

you had to get across the 85ft. bomb bay, and this is where one of the B-36's most amazing features was.

To cross over the weapons bay, crewmen used a little trolley on rails which ran through a tunnel—a mini railway!

Crews of the B-36s certainly needed to move about, as the monster aircraft would be airborne for some 30 hours at a stretch,

When contrailing, this B-36H was the first aeroplane to fly with a nuclear reactor aboard. When it first flew in 1946, the B-36 was the largest and most powerful aircraft in the world.

even in outside air temperatures of 100 degrees below zero—very tricky if the crew had to sit all that time.

On top, below and in the tail of the fuselage was the bomber's armament against enemy interceptors—no less than sixteen 20-mm cannon, the heaviest gun defence of any aircraft before. All were remotely sighted through "blisters" in the fuselage and six of them could be retracted to offer less drag to the airflow when the B-36 wanted more speed.

## SIX PUSHERS

Add to all this weight six Pratt & Whitney piston engines with their powerful pusher propellers, 21,000 gallons of fuel and four Allison (later General Electric) turbojets in two underslung pods, and you have some aeroplane.

CONTINUED ON NEXT PAGE



## FACTS AND FIGURES

Wingspan, 230ft. Length, 162ft. 1in. Height, 46ft. 8in. Weight empty, 158,843lb. Maximum loaded weight, 357,500lb. Fuel load, 32,910 gallons. Powerplants, Six Pratt & Whitney R-4360-41 turboprops of 3,500hp each, plus four General Electric J47-GE-19 turbojets of 5,200 lb. static thrust each. Top speed, 439mph at 32,120ft.; 426mph at 25,000ft. Landing speed, 121mph. Ceiling, 45,200ft. Range with 10,000lb. of bombs, 7,500 miles plus. Defensive armament, sixteen 20-mm cannon in eight remotely-controlled positions. Photo-recon RB-36s could carry 14 cameras and photo flash bombs.

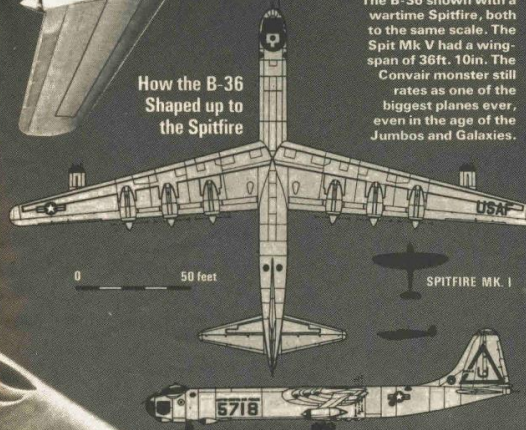
**BOMBER  
BUILT FOR  
PEACE**

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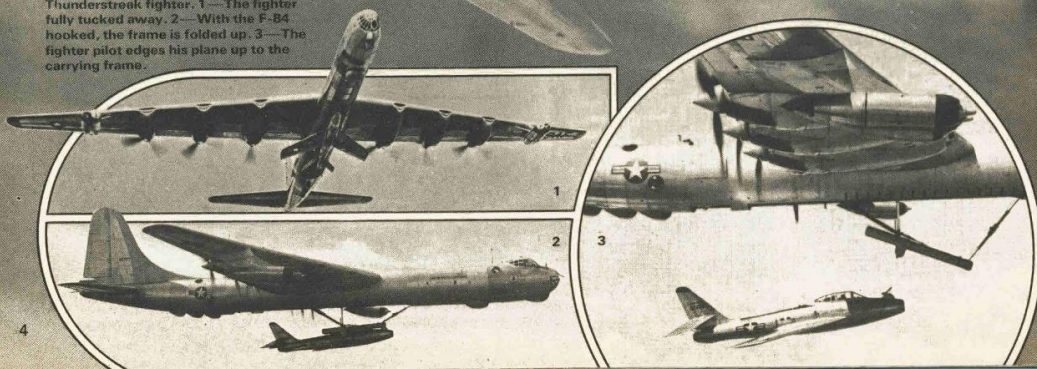


How the B-36  
Shaped up to  
the Spitfire

The B-36 shown with a wartime Spitfire, both to the same scale. The Spit Mk V had a wingspan of 36ft. 10in. The Convair monster still rates as one of the biggest planes ever, even in the age of the Jumbos and Galaxies.



Below: Three pictures that show how the B-36 became a "mother ship" for an F-84 Thunderstreak fighter. 1—The fighter fully tucked away. 2—With the F-84 hooked, the frame is folded up. 3—The fighter pilot edges his plane up to the carrying frame.



Each big B-36 cost big money, too. The first 95 on order for the United States Air Force cost the American taxpayer 6,248,686 dollars each!

In spite of all its power and grace in the air, the Convair monster was never given an official name, although plenty were put forward. One of the most popular was "Peacemaker", which turned out to be true in a way, as the aerial giant was never called upon to drop bombs "in anger" during its lifetime. Other interesting names that might have stuck to the B-36 were "Magnesium Monster", "Aluminium Overcast" and "Earthshaker".

## BOMBING SPEARHEAD

In service, the B-36 became the spearhead of the USAF's Strategic Air Command. Many long-range training flights were carried out, taking in a good deal of the world—including Britain. In January 1951, six B-36s landed at Lakenheath, Suffolk after a 24-hour flight from Fort Worth, Texas. The aircraft belonged to the famed 8th Air Force that flew bombers from the UK during WWII.

An aircraft the size of the B-36 could lift a great weight in bombs and fuel and a number of experiments were carried out to see if this ability could help new defence techniques.

Thus it was that in June 1952 the first GRB-36J went aloft.

As you can see in our photographs, the fighter used was a Republic F-84 Thunderstreak, one of the USAF's first swept-wing jet fighters. It took off independently and tucked up under the bomber's belly to "hook on". A long metal arm swung down from the bomber which was fitted with suction pads. These clamped firmly to the F-84's fuselage and held it. The arm then folded up and the fighter was drawn up under the B-36, so that the extra load gave the least possible drag to the mighty mother plane.

When the time came for the fighter to patrol, down came the arm, the F-84 slipped clear, performed its assigned mission and headed for home, or came back for a ride.

The idea of parasite fighters was not taken up operationally, even though the B-36/F-84 experiments were successful. Air-to-air refuelling was being perfected at the same time and this was obviously a much more effective way of boosting a fighter's range, and it is standard practice today.

## PHOTO SHIP

The B-36 was able to carry out its own reconnaissance missions, of course. Then, it carried a crew of 22 to operate 14 cameras, one of which had a massive 48-inch lens!

No fewer than 383 B-36s in six basic models were delivered

One of the very few big aircraft to successfully use a "pusher" engine layout, the B-36 never had to prove itself in action.

fitted with a retractable underbelly frame for a fighter. These "parasite" fighters, as they were known, were a way of enabling a fighter to stay with the bombers all the way to their targets and back. No fighter on earth could have flown as far as a B-36, so the ingenious idea to make the bomber a "pick-a-back" mother plane was tried out.

The main purpose of the fighter itself was to take photos of possible targets, but it could certainly have helped the B-36 out if the aerial opposition got a little too hot!

to Strategic Air Command up to August 14, 1954, by which time it was getting past its prime.

The giant B-36s soldiered on until 1958, when SAC was ready to become an all-jet force. Most of the mighty Convair bombers were put out to grass or broken up, but five did survive. If you are ever lucky enough to visit the Air Force Museum in America, you'll see just how huge this aircraft was. One is also being restored to flying condition in the States by a group of enthusiasts—now that should be quite a sight at air shows!



# TWO IN A TOMCAT

*What's it like to fly the world's most devastating warplane? SPEED & POWER's Ray Bonds has been asking the pilots. . .*

**T**HE US NAVY's Grumman F-14 Tomcat is all fighter, built to outfly and outscrap whatever enemy planes it comes up against. It's a twin-tailed, swing-wing, twin-engined plane packed solid with devastating weapons and carrying a crew of two—pilot and weapons operator. No matter how advanced in design, no matter how well built, the effectiveness of the plane depends on the skill, judgement and courage of those two men. That's why Ray Bonds, *SPEED & POWER's* Assistant Editor, went to the Paris Air Show—to talk to the brave men in the cockpit, like US Navy F-14 pilot Lieutenant Rick Bradley. . .

**Ray:** Today's fighter planes are crammed with advanced control systems. Although you are in control of those systems do you have the feeling of "flying by the seat of your pants" experienced by pilots flying the World War II fighter planes like the Spitfire and Hurricane?

**Rick:** I would love to have flown them—it would have been great flinging those machines around the sky. But, even today, you still "feel" the aeroplane. That flying by some kind of sixth sense is still there, but we also have the advantage of being able to rely on advanced technology in the cockpit.

**Ray:** When you take off and manoeuvre the machine do you feel a great experience of speed and power?

**Rick:** Yes, it's a

**Above:** Ray Bonds at the Paris Air Show with (left) F-14 pilot Lt. Rick Bradley, and weapons operator, Lt. Denny Gladman (right).

**Below:** Rick Bradley and Denny Gladman tap down their heavy, snug-fitting "bone" domes" before running through pre-flight checks. Then they roar into the Paris sky. . .

Wings swept, a US Navy Tomcat zooms across the sky. In the cockpit the fighter crew concentrate on visual displays giving steering commands, target information, enemy missile warnings and the vital data on carrier landing glide slope position.

tremendous sensation. But, of course, I don't often fly the plane near the ground where there is a great sense of speed. At high altitudes you hardly get the feeling of moving at all—except in a high-speed turn when there are tremendous G (gravity) forces.

**Ray:** Are you ever surprised by the machine—ever come across any unexpected dangers—or surprised by the machine's capabilities?

**Rick:** I have never been aware of unexpected dangers. Our training and experience are such that there's nothing unexpected. But, yes, I'm often surprised at what the F-14 Tomcat can do—*thankful* even! Sometimes I wouldn't expect a plane of that size to be capable of performing some of the tricky manoeuvres. But it does everything well.

**Ray:** Are you ever worried when flying?

**Rick:** Not worried—excited, perhaps. When you're preparing for an operational exercise the adrenalin pumps up in your body and you get the feeling of . . . expectancy, of something *big* about to happen.

**Ray:** When preparing for a flight you have to put so much flying gear on—boots, G-suit, overalls, helmet—and some of it is very heavy. Does this cramp your style at all?

**Rick:** You get used to it. You

**CONTINUED ON NEXT PAGE**



# TWO IN A TOMCAT CONTINUED

What do the guys then go and do on the plane? And what about things a mission you don't realize the job on.

Ray: Do you have any trouble holding your concentration over a long period—well all the most of flight instruments to check, working to a pre-arranged plan, being high and fast, hot and cold? Rick: Not really—but it is very long physically, and mentally

not really just as the designers expected?

Ray: No—basically all the working is done by computers and pilots before the plane gets to the US Fleet. They're put through a thorough computer and US Navy test programme, so I'm always confident about the aircraft. Ray: Have you ever been in any heavy situations while flying? Rick: Yes, in other places—but

exhausting. One hour is all combat manoeuvring training really uses your energy—but not while flying. You don't expect it until after, and then you feel drained.

Ray: And apart from the conventional functions of flying a high-speed attack plane you also have to hit the target. Does this put tremendous extra pressure on you?

Rick: That's the advantage of flying the Tomcat for the US Navy. The pilot flies and you have a weapons operator sitting behind you, flying, it's got him to the target—he finished the target off. One man trying to fly and operate the weapons system is too much of a burden for him to do the job properly.

Ray: Are you always confident when flying that the plane always obeys commands and control? And you even in a situation when you're worried that the plane may

not do it? When you are in a critical emergency you sometimes are inclined to get you out of trouble. This gets back to what of the plane's things.

Ray: Have you ever been afraid on a mission?

Rick: Almost! Not really I've been under fire, and then I've been concerned—but it's a job. If I wasn't afraid to go on a mission I wouldn't be able to go—I wouldn't be able to do the job.

Ray: When you're flying have you flown, and which is your favourite?

Rick: Mostly the thought F-4 Phantom fighter-bomber and the great F-4 Phantom. But without doubt my favourite is the F-14 Tomcat.

## F-14'S FANTASTIC FIREPOWER

THE GRUMMAN F-14 Tomcat now in service with the US Navy is the most formidable fighter in the world today. It can fire six missiles at no less than six different targets at one time, and hit all of them!

Its missiles can be fired at great distances from the target—a Phoenix missile fired by a Tomcat has hit a flying target over 120 miles away! The fighter also carries electronic jamming devices which will put enemy rocketry off-course. For close-in dog-fighting it carries a tremendously effective multi-barrel cannon. Flying at about 900mph at sea level (Mach 1.2) and nearly two-and-a-half times the speed of sound at 40,000ft., the swing-wing F-14 is not the fastest of fighters, but it is one of the most manoeuvrable.

In conflict, its main job would be to roam enemy skies, clearing the airspace of hostile fighters so that following bombers and ground-attack planes could fly in undisturbed. It would also protect its aircraft carriers and the fleet from air assaults. Another possibility with this amazing aircraft is that it could be armed up on a carrier as a bomber and fly 1,000 miles to drop seven tons of bombs.

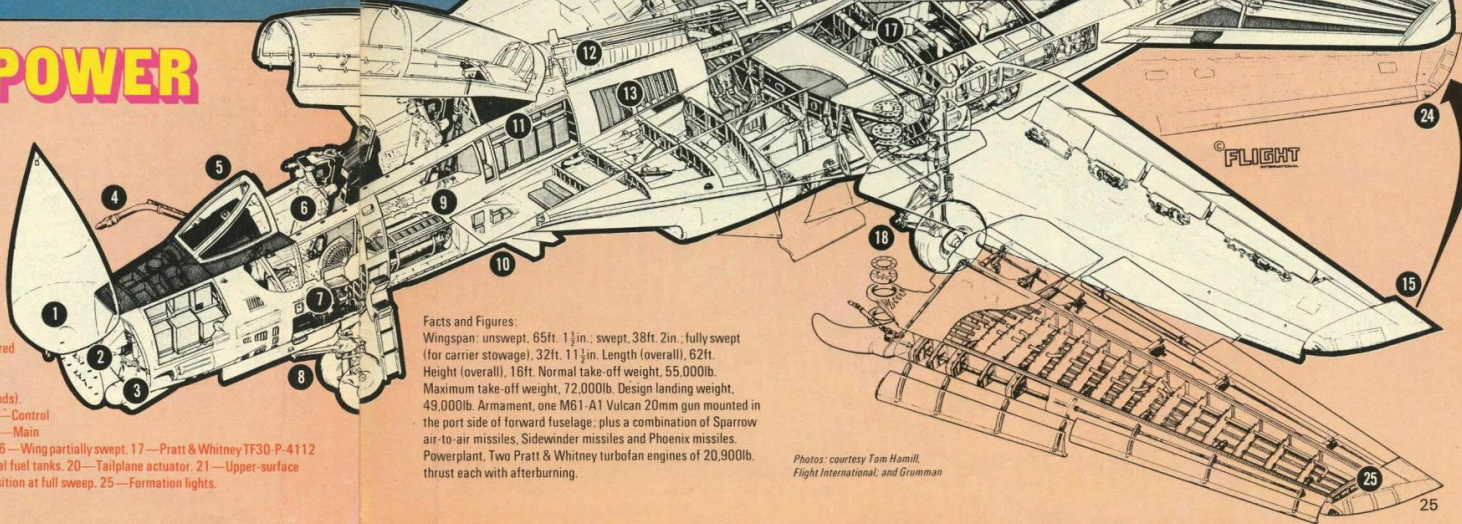
Similar in size to the F-4 Phantom, which it is designed to

replace, the Tomcat has swing wings so that it can change shape to suit the job. Unswept (forward), the wings give extra endurance (allow the plane to fly farther than usual) but give instant ability to accelerate to supersonic dash speeds. With wings fully swept to 68 degrees, it assumes its most-leared shape—that of high-performance, highly manoeuvrable, deadly fighter!

### Key to Grumman F-14A

1—Radar scanner. 2—IFF (Identification, Friend or Foe). 3—Infra-red seeker. 4—Flight refuelling probe. 5—Armoured-glass windscreen. 6—Martin-Baker ejection seat. 7—Vulcan six-barrel rotary gun. 8—Forward-retracting nosegear. 9—Ammunition tank (1,000 rounds). 10—Sparrow air-to-air missile. 11—Wing sweep programmer. 12—Control linkage from cockpit. 13—Forward-fuselage integral fuel tanks. 14—Main landing gear in retracted position. 15—Wing position at full span. 16—Wing partially swept. 17—Pratt & Whitney TF30-P-412 turbofan engines. 18—Main landing gear. 19—Aft-fuselage integral fuel tanks. 20—Tailplane actuator. 21—Upper-surface air brake. 22—Rudder actuator. 23—Arrestor hook. 24—Wing position at full sweep. 25—Formation lights.

Above: US Navy Lt. Rick Bradley flies what he calls his favourite plane to thrill spectators at the Paris Air Show earlier this year. The wings are forward in the Combat Air Patrol position. The wing position is programmed automatically to give the best performance but Rick can manually over-ride the equipment if necessary.



### Facts and Figures:

Wingspan: unswept, 65ft. 11in.; swept, 38ft. 2in.; fully swept (for carrier stowage), 32ft. 11in. Length (overall), 62ft. Height (overall), 16ft. Normal take-off weight, 55,000lb. Maximum take-off weight, 72,000lb. Design landing weight, 49,000lb. Armament, one M61-A1 Vulcan 20mm gun mounted in the port side of forward fuselage; plus a combination of Sparrow air-to-air missiles, Sidewinder missiles and Phoenix missiles. Powerplant, Two Pratt & Whitney turbofan engines of 20,900lb. thrust each with afterburning.

Photos: courtesy Tom Hamill, Flight International, and Grumman

Left: A lethal F-14 on patrol. To give an idea of how deadly the plane is, imagine 24 enemy fighters ahead: that one Tomcat can track all of them and pass on the data to other F-14s. It is joined by three more Tomcats, and then the four of them can simultaneously shoot down all 24 enemy aircraft!

Above: Lt. Rick Bradley, in the "front seat", is in intercom link with the chief groundcrew engineer as they run through the pre-flight check on the Tomcat at Paris.



12p Weekly No. 76 August 29–September 5, 1975

# Speed & Power

**PLANES**  
**CARS SHIPS**  
**SCIENCE FICTION**  
**TRAINS**

Bobbing down an  
ice mountain!





## Writers in the Sky

*The idea of writing messages in the sky with smoke trailed by aeroplanes caught many people's imagination between the wars. . . .*

IN THE YEAR 1922 Derby Day fell on May 30. Tens of thousands of people swarmed to the racecourse at Epsom Downs, south of London, to enjoy one of the greatest open-air spectacles of the year. It was a beautiful day, and there was not a cloud in the sky.

But . . . wait a minute! Yes, there was just a tiny white cloud, right overhead. Curious, it was growing into a curved white line. . . . Slowly it became a perfect letter C. Then other letters followed. Eventually the message spelt out

the word CASTROL, the name of the best-selling motor oil.

### WHO AND HOW?

Not one of the vast crowd could get the fantastic message out of his or her mind. It must have been written there, but how and by whom? Some said they had seen a tiny aeroplane doing it, but how could an aeroplane write? Many thought the whole thing was supernatural, and wondered if it was the devil at work (but why should the

devil go in for the advertising business?).

In fact, on that beautiful May day, the Derby crowd watched "skywriting" for the first time. At least it was the first time in public. Anyone on the deserted coast of Essex over the previous nine months might have seen the results of the early experiments to get the method to work, and the first attempts by pilots to write neatly.

The man behind it all was Major Jack Savage, who had been mixed up in some of the pioneer flying

from 1911 onwards. Often, watching early aviators, he had thought, "If only there was some way to make the aircraft trace out its path." He thought it would be pretty, that it might help engineers study the airflow, and that it might even be useful as a way of sending messages to the ground.

And in 1912 the Editor of the magazine *Flight* (published by the same company as *Speed and Power*) made this startling prophecy: "I

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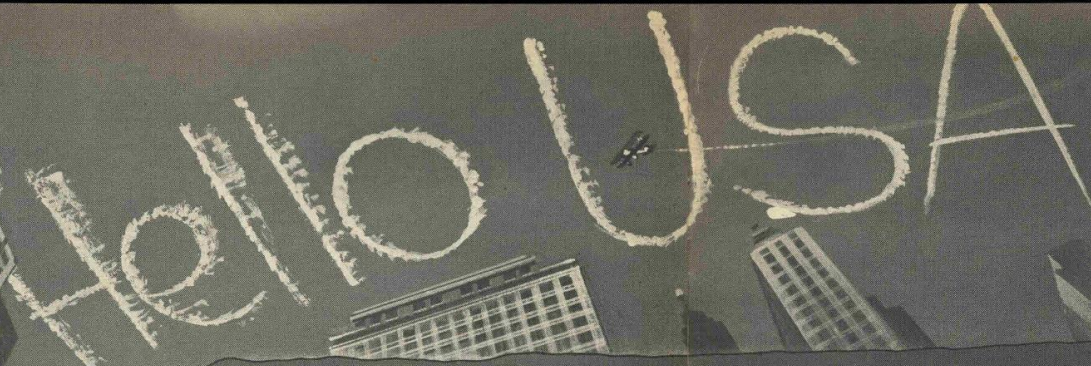
will even go so far as to imagine the time as not far off when, on seeing an airman climb skywards, we shall watch to see whether he is going to tell us in aerial evolutions to 'Give him Bovril!' The time was not far off—just ten years!

What happened in those ten years was that World War I left the world overstocked with surplus aeroplanes and pilots. Savage had worked hard on his idea, patented a way of making smoke to order and hired a brilliant pilot, Cyril Turner, to do the test flying. It took a lot of experimentation to produce the white smoke that could best be seen against a blue sky.

Eventually a way was found to run oils from a special tank into specially lengthened engine exhaust pipes. This gave a good result, but it could not be shut off quickly; the white line just gradually got

**Above: When the Jack Savage sky-writing "circus" arrived in the USA in 1922, not many people seemed interested in placing business, so New Yorkers were treated to this novel introduction! The outfit also wrote its 'phone number over the city and within three hours over 7,000 calls jammed the lines into Curtis Field, where the S.E.5A biplanes were based.**

**Below: A typical scene at Hendon, home of the Savage skywriters.**



**When ace skywriter Cyril Turner wanted to tell girl stunt flyer Andree Peyre how he felt about her, he decided to let a lot of other people into the secret! Over the US city of Los Angeles, I LOVE YOU appeared as the tiny S.E.5A wrote the words by channelling smoke through its exhaust system.**



thinner, so letters could not be started and finished nearly. Finally, in August 1921, a way was found to divert the hot exhaust through the smoke system to write the letter and then, as the letter was finished, divert the gas away again, shutting off the smoke suddenly and completely.

But it was still difficult to write well. A typical word might be five or six miles long, written at 10,000 feet, and the whole thing was very public! It had to look neat, and be done exactly right first time. If the pilot got even slightly out of place, or lost, or forgot where he had got to, the result would be disaster. He could not rub anything out, or start again!

To make it harder, he had to write the letters upside-down and backwards, and could not see the letters as they were written. Turner found the best method was to write the words on a sheet of glass and look at them from both sides, holding the glass in the flat, horizontal position in which the words would be written in the sky.

Then he would work out the best way of writing them. As aeroplanes cannot go round sharp

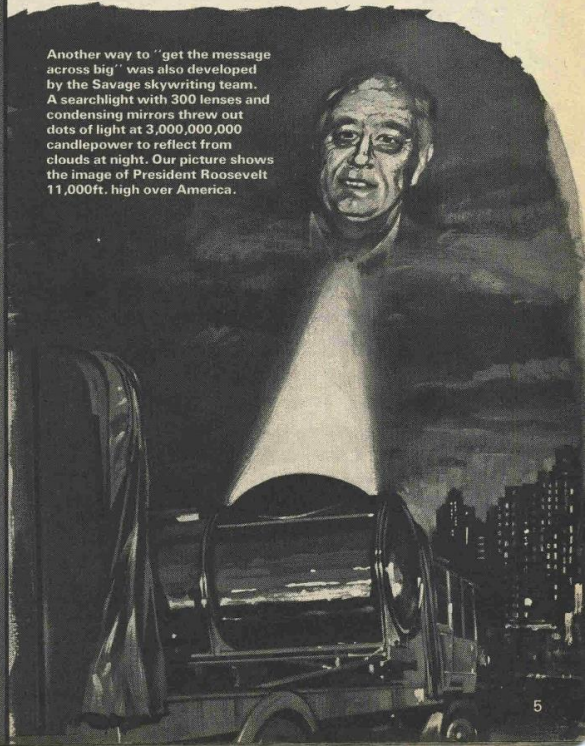
corners he had to play tricks at corners by either kicking on sharp rudder and "turning a square corner" or by breaking off and beginning again at just the right point in the new direction.

For more than 12 years Savage's aerial skywriting company advertised dozens of products all over Britain, the Continent and the United States. Some people thought it was wicked to plaster advertising over the heavens. One woman in France thought it was the end of the world and prayed for three days (despite the fact that it said CITROEN), and in California Turner spelt out "I LOVE YOU" 10,000 feet above the girl he was soon to marry.

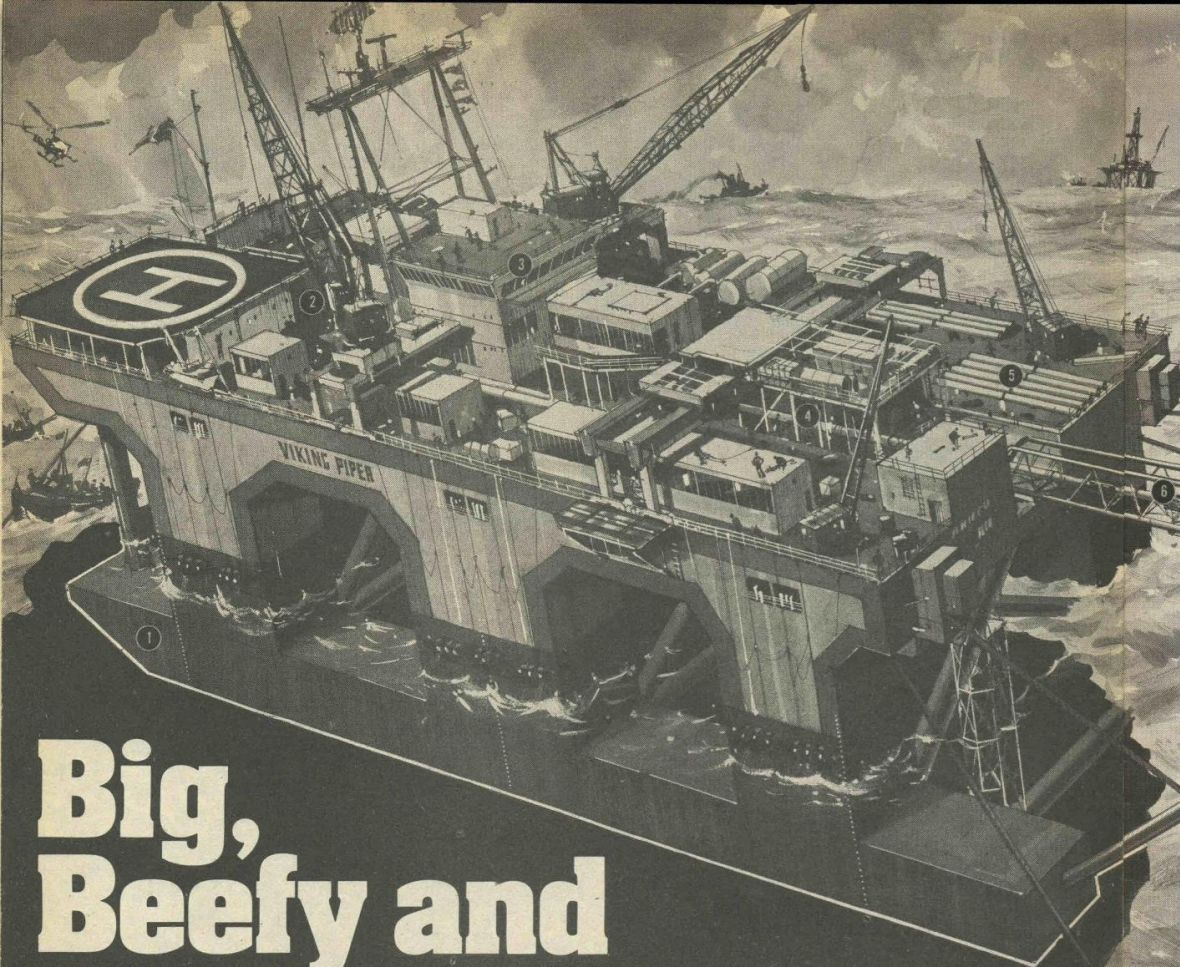
## FADE OUT

Then, gradually, skywriting faded. The novelty had worn off by the mid-1930s, and business was not so good. But three of Savage's skywriting planes, all S.E.5A fighting scouts from World War I, are still in existence; you can see one in the Science Museum, London, and another at the Shuttleworth collection in Bedfordshire.

**Another way to "get the message across big" was also developed by the Savage skywriting team. A searchlight with 300 lenses and condensing mirrors threw out dots of light at 3,000,000,000 candlepower to reflect from clouds at night. Our picture shows the image of President Roosevelt 11,000ft. high over America.**







# Big, Beefy and Businesslike—

## Viking Piper beats the waves

*Everything about North Sea oil seems to be big—the rigs, the pipe-lines and the problems! To overcome these there's a new pipelaying barge—the biggest there has ever been...*

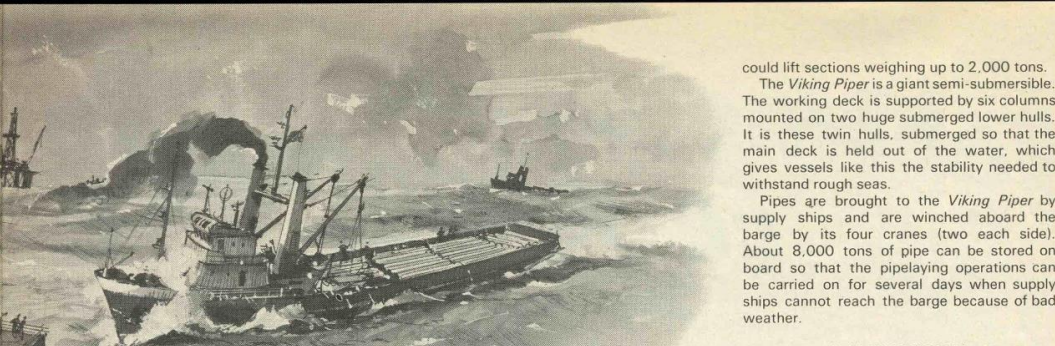
**W**EATHER conditions in the North Sea are quite often nothing short of terrifying, with enormous, heaving waves and howling gales. But that's where oil can

be found—vital black gold, millions of gallons of it lying under the sea bed, waiting for brave men to go and pump it out.

Man has always fought to overcome the

elements, and so we have seen huge drilling rigs towed out to the middle of the ocean and set up to suck out the oil which can mean prosperity to a nation. But while men have been pumping oil from ocean beds all over the world for many years, they have only recently begun to appreciate the perilous conditions they face in the North Sea.

One of the problems they have come up against is that the barges which laid pipelines in the Gulf of Mexico, for instance, are just not big enough or stable enough to cope with the weather conditions or depth of water in



**Left: The Viking Piper can ride out much rougher waves than previous generations of pipe-laying barges could. She has (1) twin submerged hulls; (2) four cranes for lifting pipe aboard from supply vessels; (3) the bridge containing highly sophisticated control and communications systems; (4) automatic welding equipment; (5) storage space for 8,000 tons of pipe; and (6) a novel stern ramp through which the welded pipe is fed into the sea.**

### LAUNCHWAY

The pipes are joined on deck then moved on conveyors to a launchway in the centre of the barge. From here the jointed pipe is fed on to a long stern ramp (looking like a crane jib and extending from the rear end of the barge).

It is thought that *Viking Piper* will be able to lay pipe quicker than any vessel has before. It's quite an operation, for some of the pipe measures about 44 inches in diameter. Pipes of smaller diameters could be laid in water over 1,200 feet deep in quite heavy seas. If the weather gets too rough for even *Viking Piper* the stern ramp's wet end (the end in the water!) is raised above the waves.

On previous barges the ramp often had to be disconnected and abandoned for fear that it could put the vessel in peril. When the weather became calm, the abandoned ramp would have to be recovered and reconnected before pipelaying could be resumed—quite a time-wasting operation. But *Viking Piper* would simply lower her stern ramp and pipelaying could be started again immediately.

As you can imagine, such an operation requires a big work force. There will be about 300 men on board *Viking Piper*, and to keep them amused while they are not working there are a games room, cinema, library, cards room, television room, besides a hospital, a galley, and mess rooms designed to provide comfort and privacy.

The barge's upper hull, or platform, is filled with machinery, storage and crew accommodation, and there are extra machinery spaces in the submerged hulls.

Control of all the equipment on board is handled by four computer systems, but the officers and engineers can take over manually when necessary. Of course, communications play a large part in a pipelaying operation, and the vessel is equipped to keep in touch with supply ships and shore bases, as well as all the work areas aboard its vast deck. There is also an aircraft beacon and communications system, and a helicopter deck.

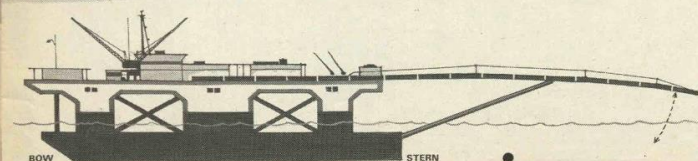
Like all similar vessels, *Viking Piper* has equipment for the divers that work with her—two decompression chambers, one transfer chamber and a diving bell capable of going down to 1,000 feet.

All in all, she's one of the strangest craft to be seen afloat, but then *Viking Piper* has no ordinary task to perform. She will be helping to make full use of one of the world's most important natural resources.

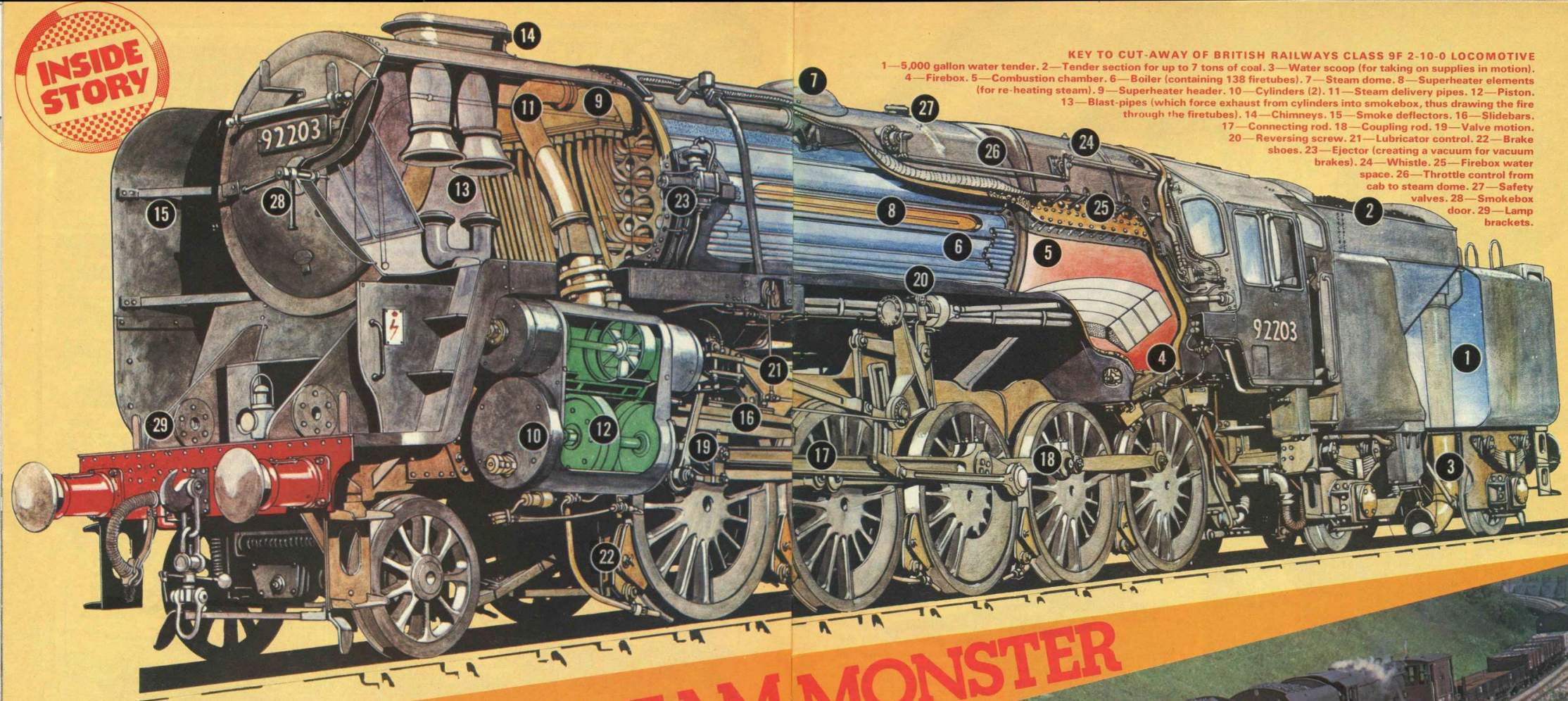
the North Sea. But now a new generation of barges is at sea and pipelaying can be carried out in waves even higher than 15 feet, which would force the older vessels to break off and sit out the storm.

One of these new barges is called *Viking Piper*, and it was launched earlier this year by IHC Gusto in Rotterdam. Well, launched isn't truly correct—because it is so huge that there's not a shipyard in the world big enough to launch it. Instead it was built in the water—parts in Ireland and parts in Holland—then put together in Holland to form a massive vessel about 540ft. long overall, 190ft. wide and 110ft. high. A special, gigantic straddle crane had to be built to help construct the barge, and this needed a platform which

**Below: When the weather gets too rough, the Viking Piper lifts its stern ramp clear of the waves and can continue pipelaying almost immediately when conditions become calm again.**







KEY TO CUT-AWAY OF BRITISH RAILWAYS CLASS 9F 2-10-0 LOCOMOTIVE  
1—5,000 gallon water tender. 2—Tender section for up to 7 tons of coal. 3—Water scoop (for taking on supplies in motion).  
4—Firebox. 5—Combustion chamber. 6—Boiler (containing 138 firetubes). 7—Steam dome. 8—Superheater elements (for re-heating steam). 9—Superheater header. 10—Cylinders (2). 11—Steam delivery pipes. 12—Piston.  
13—Blast-pipes (which force exhaust from cylinders into smokebox, thus drawing the fire through the firetubes). 14—Chimneys. 15—Smoke deflectors. 16—Slidebars.  
17—Connecting rod. 18—Coupling rod. 19—Valve motion.  
20—Reversing screw. 21—Lubricator control. 22—Brake shoes. 23—Ejector (creating a vacuum for vacuum brakes). 24—Whistle. 25—Firebox water space. 26—Throttle control from cab to steam dome. 27—Safety valves. 28—Smokebox door. 29—Lamp brackets.

# BRITAIN'S STEAM MONSTER

**P**OUNDING ALONG the main line came British Railways' biggest steam locomotive, its ten driving wheels turning round, shrouded by steam escaping from the thrusting cylinders. Darting through the countryside, the engine was coping with its 500-ton freight train with ease; for it was one of the powerful 9F class, introduced in 1954.

In March, 1960, the last steam engine to be built for British Rail-

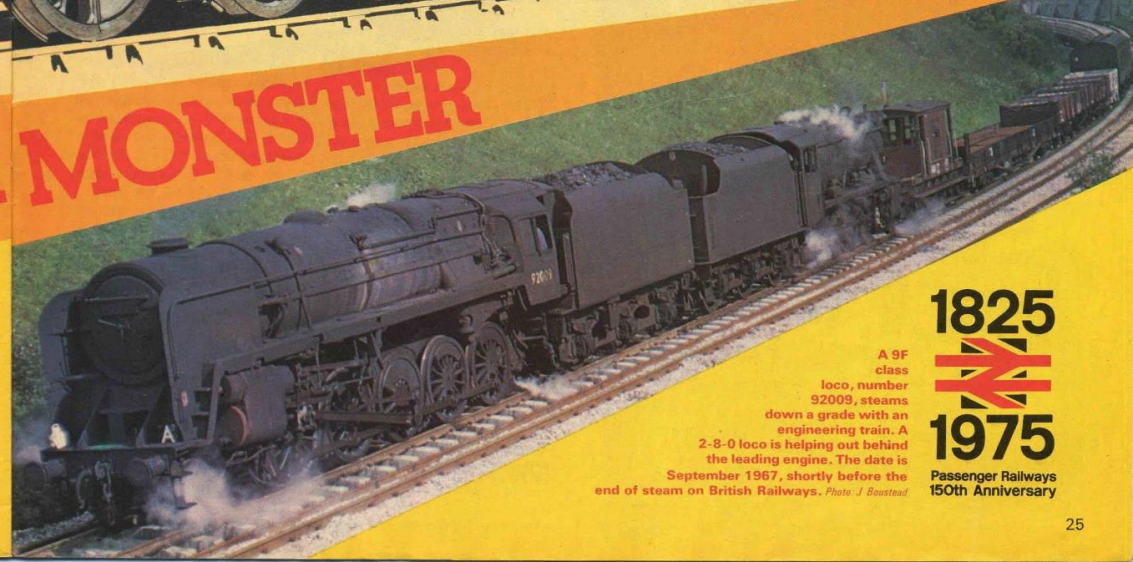
ways left the workshops at Swindon. This was a member of the 9F class, it was named *Evening Star* and heralded the sunset of the steam era. A total of 251 of these mighty engines had been built.

One of them was number

92203, later named *Black Prince*, illustrated here. It was given this name by famous wildlife painter and railway enthusiast David Shepherd, who saved the engine from the breaker's torch and preserved it in working order on the East Somerset Railway, Cranmore, where it can be seen today.

This loco, and the others in its

class, were mainly used for heavy freight trains, but were occasionally used on fast passenger services on the main lines of all regions except the Scottish. Top speeds of around 85mph were recorded, and this was pretty high for locos of this kind, which were designed mainly for "heavy haulage" jobs.



A 9F class loco, number 92203, steams down a grade with an engineering train. A 2-8-0 loco is helping out behind the leading engine. The date is September 1967, shortly before the end of steam on British Railways. Photo J. Boustead

1825  
1975  
Passenger Railways  
150th Anniversary



12p Weekly No.77 September 5-12, 1975

# Speed & Power

GRASSHOPPER  
CHOPPERS

MARINES  
YRON-1  
4002

FAST  
FIGHTING  
FRIGATES

PLANES  
TRAINS  
SCIENCE FICTION  
MODELS





# FLYING WIGS !

Flying Wigs? No, we haven't left the "N" out of the word "wings"—WIGS stands for Wing in Ground Effect, and that means a whole new generation of aircraft whose place is not up in the clouds, but just above the ground!

A SLIGHT swell is running in the Caspian Sea. The captain of a giant new Russian flying-boat arrives at the test area for another series of trial flights. Climbing into the cockpit, he and his co-pilot run through the pre-flight checks.

Soon, engine throttles opened to full power, the craft hurtles across the seaway both wings and engines tilted downwards. In a few seconds, it's reached its normal operating height—just fifty feet!

This Soviet flying-boat of the future is known only as the "Ekranoplan Experimental" at the moment, but what it is and what it does could soon be quite a shake-up for world aviation thinking.

The secret lies in that amazingly low altitude. For, unlike conven-

CONTINUED ON NEXT PAGE



A mighty Soviet Navy WIG flying boat flying with a civilian twin-hulled machine built for a similar cruising altitude—about 50 feet above the waves! Think of the potential of these fantastic machines—by keeping low, they use the natural lift from a cushion of air and much less fuel than a conventional aircraft, but are able to carry more freight—or people—at great speeds.



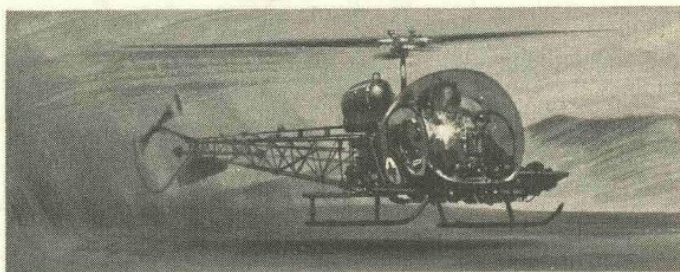
tional aircraft, which depend on their wings and forward speed from their engines to generate lift to keep them in the air, the Ekranoplan uses what is known as "ground effect" for part of its lift—the air pressure that is always just above the surface of the land or sea. Sandwich this pressure under a wing, and you can't help but keep up.

## WIG ALL THE WAY

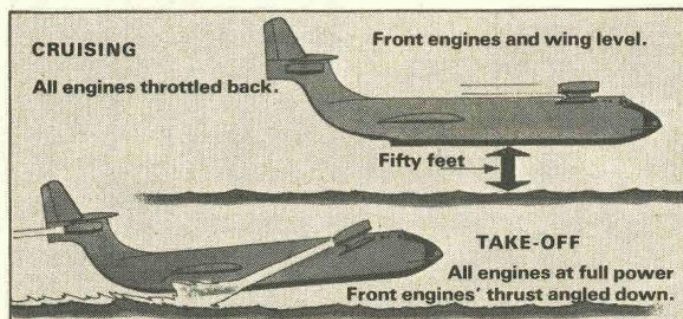
Aircraft which are specially designed to use ground effect are known as "Wing in Ground Effect Machines", or WIG for short. Of course, all aircraft feel this ground effect at times, usually during take-off and landing. But the Ekranoplan is designed to take advantage of it during the *entire* flight.



**Above:** A Dornier Do-X was one of the aircraft to find out about WIG-type flying when the crew found they could save fuel by flying low over the Atlantic. The air "cushion" near the sea helped support the aircraft's sponsons and wings.



**Above:** In the right conditions, helicopter pilots can use ground effect, too. In a heavily laden craft, the pilot can get off, build up speed and climb away gently, keeping power in hand. Otherwise, he'd burn fuel at full power on lift-off.

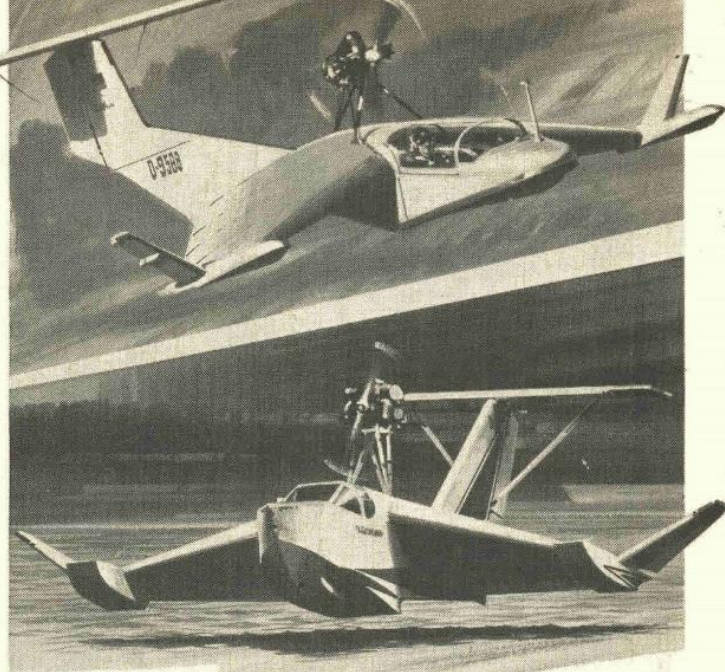


**Above:** This is how you get a 400-foot long aircraft up to its 50 feet altitude. The jet deflection would also have to be "turned up" to get a WIG monster flying-boat over obstacles near the ground. The nearer the ground these aircraft can fly, the better lift they get from their engines and wings.

At speed, WIGs get lift very much like a hovercraft, so they have to stay at 25 or 50 feet above the surface, depending on their size.

By flying so low, the drag on the aircraft can be reduced by as much as 70 per cent. And the effect of this drag can be seen by the fact that once a WIG has reached a speed where it is being supported by the air cushion, it needs up to three and a half times less engine thrust on take-off. Also, it has been reckoned that a conventional aircraft can carry only nine pounds for each engine horsepower, while a WIG aircraft can manage up to 44 pounds—now that *is* a saving!

But, like many good ideas, WIGs are not that new. Way back before the last war, German



**Top:** After a brilliant wartime career, which included designing the fantastic Messerschmitt 163 rocket plane, Dr. Alexander Lippisch went on to develop WIG aircraft. The most recent is the X-113 Am Aerofoil Boat, which first flew in October 1970. Tests have shown that the craft uses half the power of its 48hp four-cylinder engine in ground effect at over 100mph. Another Lippisch project for a WIG aircraft is a six ton river bus.

**Above:** Similar in design to the Lippisch WIG craft, the Russians have flown a number of Eska craft. About 25 feet long, they are powered by a 30hp motor bike engine. This gives them a speed of about 75mph at only three feet above the water or land.

flying boat crews flying machines like the giant Dornier Do-X across the South Atlantic, found that they could save fuel by flying low down, using the ground effect principle.

The Germans continued research in many fields during World War II and one man who has carried on his work is ace rocket engineer Dr. Alexander Lippisch, who also thought out the delta wing shape for high speed aircraft.

Over the last ten years, Dr. Lippisch has worked on Air Cushion Vehicles and has designed the amazing Aerofoil Boat with a reversed delta wing, making it able to fly in and out of ground effect without trouble.

Speeds of up to 180 knots have been achieved by the Aerofoil Boat and the Lippisch company has put forward a number of designs for flying at very low level, including ocean-going craft weighing up to 100 tons.

But it is the Russians who lead the world in WIGs at the moment. Their Ekranoplan Experimental is the largest WIG yet built anywhere in the world. It has a main wing span of 125 feet and is 400 feet long. The engine-carrying

stub wings are about 40 feet in span. Eight of the aircraft's ten engines are mounted here, the other two nestling under the large "T" shaped tail.

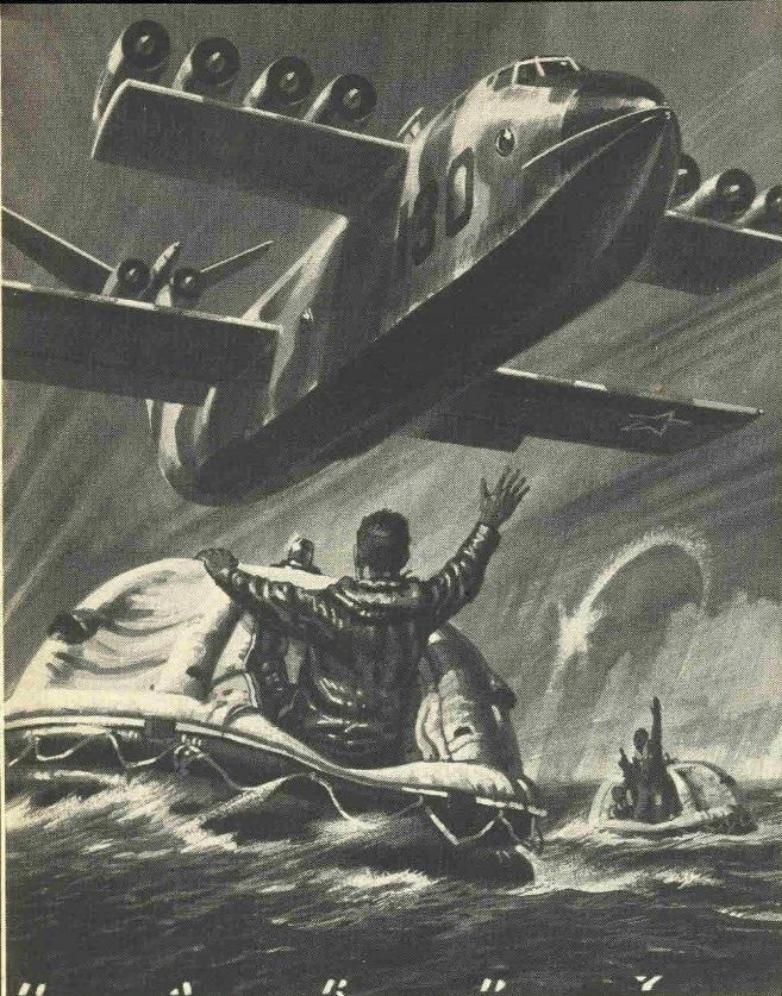
Thrust from the wing jets is deflected downwards into the water under the main wing during takeoff, to push the Ekranoplan to its cruising height. This thrust is then deflected over the top of the main wing to create additional lift. The aircraft's other two engines are used to boost thrust during take-off.

## BRIDGE LEAPER

We don't know everything about the Ekranoplan, but Western aviation experts believe that the giant flying boat is able to make about 300mph. It can fly over any sort of flat smooth surface, such as ice, sand or water and also lift over low obstacles like bridges.

It is thought that the Russian Navy is particularly interested in using machines like this for military supply missions, armed and anti-submarine patrols and minesweeping. The aircraft shown in our drawings would be able to move no less than 800 armed troops at once!





**Left:** As an air-sea rescue craft, the giant Russian WIG flying boats would have much more chance of spotting a downed flier than an aircraft that must stay higher.

**Above:** Submarines would have to look out for depth-charge armed WIG flying boats, too.



**Above:** A Russian Army Loadmaster would have a huge task when the order came to move a *whole army* a few thousand miles during a military operation. Equipped as amphibians with skid undercars, WIG flying boats would have great mobility and they wouldn't need prepared runways to land in the battle zone. Also, as shown here, land survey teams could move their heavy gear with ease with WIGS.

Just a few WIG flying boats could move a pretty large army a great distance in a few hours, along with its guns, vehicles and supplies. Warships and submarines could be completely resupplied at high speed while still at sea, and the use of WIGs could mean the difference between defeat and victory in a war.

Being low fliers, WIGS would also be difficult to shoot down—they could only be attacked from the side or above, and radar would have a job tracking them at less than 100 feet up.

WIGs can just as easily become mighty passenger lifters, and we've also shown you here the Russian idea for a River Bus.

This super-looking "flying catamaran" would have twin hulls with six turbojets to power it over inland waterways, much as Soviet hydrofoils do today.

Such a WIG as this would be about 100 feet long and carry up to 40 passengers in each hull at speeds of up to 150mph—that's some river bus!

Although no river prototype is known to have flown, we think that five-ton models have been tried out.

Smaller Russian WIG craft that have been in use for the past few years are the Eska series. These mini flying-boats are just under 25 feet long with a 24½-foot wingspan. Tipping the scales at 1,000lb., they are powered by a single 30hp motor cycle engine giving up to 75mph at a height of just over three feet.

Other nations, including France and America are taking interest in the progress of WIGs and have their own ideas underway. So, one day, we may see the return of the flying boat in a big way.



AT A COMMAND from the bridge, HMS *Amazon*'s gas turbine engines build up full power. Her bow rises from the water as the twin propellers thrust her through the waves at a top speed of close on 40mph. She's just emerged from some pretty rugged weather in mid-Atlantic, and she performed extremely well according to those who know, the ship's officers.

Since you're aboard one of the fastest frigates in the world, the first of the Royal Navy's Type 21s, we'll show you around the ship's weapon systems. You'll soon appreciate that, first and foremost, she is a *warship*—a new class of frigate, smaller than many others, but faster and packing just as much punch. She will be able to patrol any waters of the world, in any weather, protecting a convoy or other force from attack by enemy surface ships or subs. She'll also be able to look after herself against aircraft, missiles and fast patrol boats.

Looking forward from the bridge, you can see the mighty Vickers 4.5 inch Mk. 8 automatic rapid-fire gun which can be used to pound surface and air targets. Below the bridge, slightly forward on each side, are the two 8-barrelled Corvus rocket projectors for radar-reflective and flare decoys, which should help confuse an enemy! Each side of the bridge is a 20mm Oerlikon gun for close-in skirmishing.

If you walk aft now, up to the deck above the hangar, you will come across the missile launcher. It can fire four Short Seacat close-range surface-to-air missiles, standard armament aboard many Royal Navy ships. Some of the later Type 21 frigates will be equipped with French Exocet surface-to-surface missiles as well. These can be used in all-weather attacks against other surface vessels.

The hangar below the missile launcher will eventually house the superfast Westland Lynx helicopter, the speed record-breaker which has been designed for long-range submarine detection and attack. It would also be used against missile-armed fast patrol boats. This new aircraft will be one of the most effective weapons attached to the frigate family, for its armament will include anti-submarine torpedoes, air-to-surface guided missiles and two 20mm Oerlikon guns.

## RADAR AIDS

With all this weaponry, how does this fighting frigate know what to aim at? Well, she is jammed solid with sophisticated electronic aids, like target-fix and weapons tracking radars forward of the missile launcher just aft of the "funnel" and also just above and behind the bridge. At the top of the forward mast is the weapons radar aerial (as distinct from the direction-finding aerial mounted above the "funnel"). Attached to the hull are search and attack sonars, and two computers are used to control the weapons system in the frigate. The Lynx helicopter also has surface search radar.

So you can see, although the Navy's newest frigate gives great comfort to the crew and is a good-looking, sleek vessel, there's no question what her purpose is. Eight Type 21s are planned; seven have already been launched: *Antelope* has joined *Amazon* in commission with the Royal Navy, while *Ambuscade* will join the Fleet very shortly. Look out for the day when the sister ships *Active*, *Arrow*, *Alert*, *Ardent* and *Avenger* are completed to provide Britain with a tremendous fighting force!

# FAST FIGHTING FRIGATES

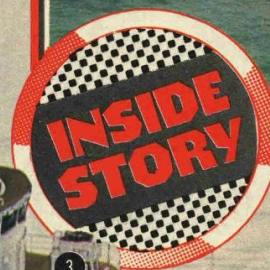
About a year ago, we introduced you to HMS *Amazon*, first of the Royal Navy's Type 21 frigates. Now we invite you to look over the fire-power of this high-speed warship . . .

Left: HMS *Antelope* (F170), second of the Royal Navy's new Type 21 frigates, parts the waves in the English Channel off the Isle of Wight.

Right: *Ambuscade*, after her launch, looks just the bare bones of a frigate. But soon, once she's fitted out like her sister ships *Amazon* and *Antelope*, she'll be one of the most powerful warships, size for size, in the world. Below: The Royal Navy *Lynx*, planned to serve with the Type 21 frigates, would be the scourge of any enemy submarines it was sent out to seek and attack with torpedoes.



Right: HMS *Amazon* is being tracked by *Antelope*, flying the red ensign, showing that she had not yet been commissioned when the photograph was taken. It is planned that by 1978 there will be eight Type 21 frigates in commission.

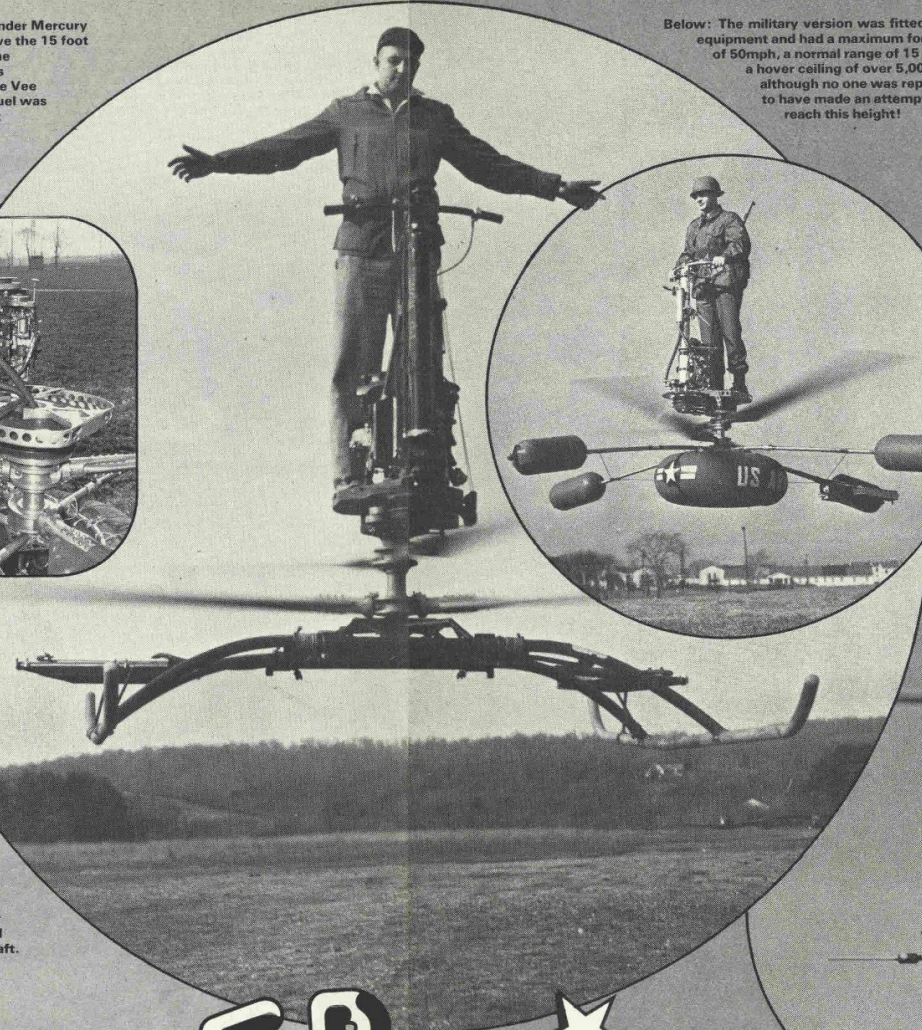
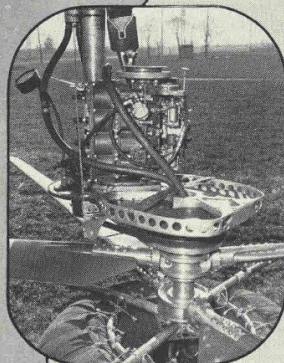


**KEY TO CUT-AWAY OF HMS *AMAZON*, TYPE 21 FRIGATE**  
 1—Automatic 4.5 inch Mk. 8 gun. 2—Hatch access to forward part of hull containing stores and magazines. 3—Two eight-barrelled rocket projectors. 4—Enclosed bridge. 5—20mm Oerlikon gun (one each side). 6—Weapons tracker. 7—Weapons radar aerial. 8—Direction finding aerial. 9—Seacat missile launcher. 10—Flight deck. 11—Hangar for Lynx helicopter. 12—Junior ratings dining hall. 13—Generator room. 14—Cruise gas turbine room. 15—Main gas turbine room. 16—Generator room. 17—Wardroom. 18—Senior ratings accommodation.

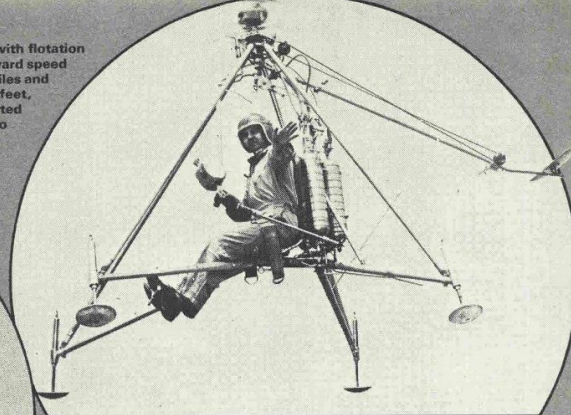




Below: The four cylinder Mercury outboard used to drive the 15 foot diameter rotors on the Aerocycle. Drive was transmitted by a large Vee belt and pulley and fuel was carried in the upright column.



Below: The military version was fitted with flotation equipment and had a maximum forward speed of 50mph, a normal range of 15 miles and a hover ceiling of over 5,000 feet, although no one was reported to have made an attempt to reach this height!



Above: Fitted with rotor-tip hydrogen peroxide rockets, Pinwheel required no warm-up period and could take-off in seconds, leaving no tell-tale trace of exhaust smoke or flames—a boon to Helitroopers. Below: First flown in June, 1945, this Bendix one-man chopper had a top speed of 96mph and a range of 85 miles. It was the first mini-chopper to use counter-rotating blades.



All aboard the Flying Doughnut—a step-on chopper platform which gets its lift from a ducted fan. Developed by the American company of Hiller in the late 1940s, the aerial platform was designed to carry assault troops over rivers, rough terrain and swamp-lands. A small diameter shrouded fan, driven by two air-cooled 40hp motors, gave the craft a top speed of 36mph and a range of 17 miles. The platform was simply steered by the soldier leaning in the direction he wanted to go. Right, centre: Look Mum, no hands! And no legs either if the luckless pilot should slip off the tiny platform of the deLackner Aerocycle, for it was fitted with coaxial counter-rotating rotors just below his feet. Powered by a 43hp Mercury outboard motor its controls consisted simply of a throttle and "body leaning" was again used to steer the craft.



# CRASSHOPPER CHOPPERS

Originally designed to be para-dropped to the pilot of a downed plane so he could fly himself to safety, and for turning a soldier into an aerial attacker, these experimental one-man mini-choppers would be just right for beating bus queues and traffic jams.



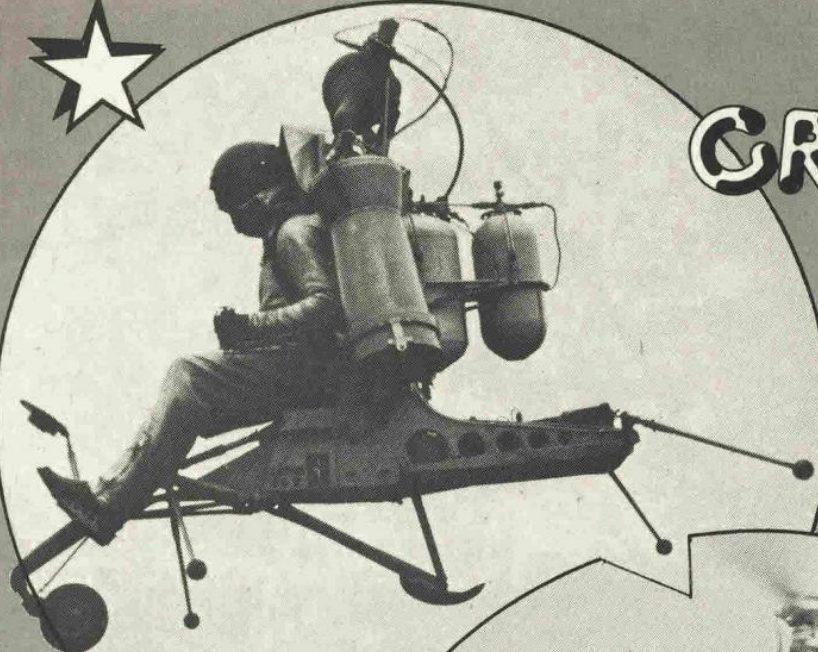


# CRASSHOPPER

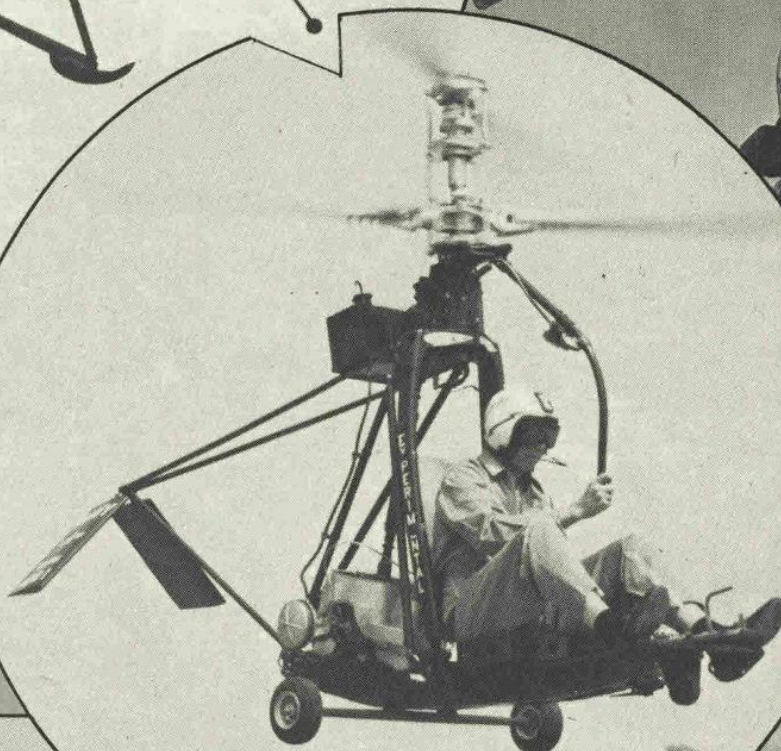
## CHOPPERS

CONTINUED

Left: Rocket power gave this Sud Aviation terrain-jumping craft its lift and VTOL capability. The two nozzles, mounted each side of the craft, could be directed by the pilot to control pitch and roll, and vanes in the mouths of the exhaust "trumpets" gave forward and backwards movement. Top speed was 62mph and with a 30 second burn the craft could travel 2,500 feet at an altitude of 650 feet.

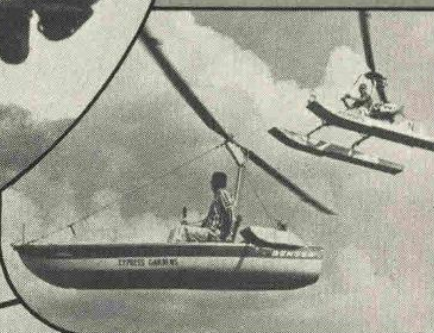


Right: First test flown in 1955, the Gyrodyne Rotorcycle had a top speed of 78mph. Powered by a 40hp engine it had twin rotors and a fixed inverted V-tail for directional stability. The engine, mounted low behind the pilot, drove the coaxial rotors through a shaft to the gearbox located directly beneath the rotor hub. The craft weighed less than 500lb. and was fully collapsible for ease of transportation.



Above: Built in 1953 for a US Navy "Rotorcycle" competition, the Bensen Mid-jet weighed just 100lb., and had a 15-ft. diameter rotor driven by 50lb. thrust ramjets fitted to the tips.

Below: The Bensen helicopter company turned this aluminium hull into a flying boat by fitting it with the rotor assembly identical to that used by their Gyro Copter shown hovering in the background.



Far left and left: The Hiller entry for the US Navy competition to find a one-man helicopter to transport Marines in ship-to-shore attacks was this XROE-1 "Rotorcycle". Quick-release pins enabled it to be assembled and flown within a few minutes of being unpacked. It was powered by a 25bhp two-stroke four cylinder engine driving a rotor system which included a smaller stabilising rotor. With 2½ gallons of fuel on board it could whisk a fully equipped Marine ashore at a maximum speed of 66mph.





# TIN TOUGHIES!

*Although lightly armoured, the devastating range of weapons that can be carried by these French vehicles make them into tough nuts for an enemy to crack!*

**F**IRST produced for the French Armed Forces in 1961, the Panhard AML armoured car is used for battlefield reconnaissance, frontier protection, convoy escort and internal security. Powered by a 2-litre air-cooled 90bhp engine, the vehicle is particularly reliable, silent and speedy, making it ideal for these sort of duties. Special features include puncture-proof tyres which have an inner tube made up from numerous separate cells filled with nitrogen during manufacture. Even if the outer casing of the tyre is shot to pieces or blown up by a mine, this "inner tyre" will still enable the AML to travel at speed. A crew of three—commander, gunner and driver—operate the vehicle which can carry a variety of turret weapons including a 60mm mortar, 90mm gun, two 20mm anti-aircraft guns and SS11 missiles, depending on its military role.

A later development of the AML is the Panhard M3 which uses 95 per cent of its mechanical parts and is designed for counter-insurgency and internal security where large numbers of men have to be carried swiftly and safely to a trouble spot.

A complete mobile workshop, the M3 VAT carries four mechanics and a driver. Fittings include an overhead pulley block and tackle, oxy-acetylene welding equipment, an on-board generating set, workbenches, a full range of power tools, working searchlights and towing equipment. It is used to service the AML and M3 range of armoured cars and is armed with a roof-mounted machine gun. Like all M3s it has a welded hull.

The anti-aircraft turret fitted to this M3 VDA turns the armoured car into a unit that can protect parked military vehicles or give fire support to advancing infantrymen as well as defence against low-level aircraft attacks on bases, bridges and supply dumps. The turret is equipped with two 20mm guns firing between 800 and 1,050 rounds per minute and is operated by one man. Radar gives warning of attacking aircraft up to 5 miles away and automatically computes the target angles and hydraulically tracks the gun.

Four-wheel drive, transmitted from the front-engined M3 to the rear wheels by propeller shafts passing down each side of the vehicle, enable this Armoured Personnel version to tackle steep river banks with ease. Ten infantrymen plus a crew of two are carried. Numerous firing ports, plus two roof-mounted machine guns give the vehicle formidable firepower and it is fully amphibious without preparation. Other variants include a radio/command vehicle, a cargo carrier and an armoured ambulance.



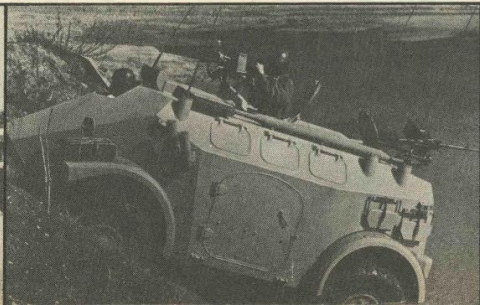
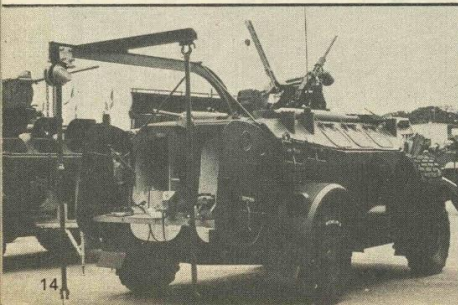
Above: The air-portable AML 60 is armed with a 60mm breech-loading or muzzle-loaded mortar. An amphibious kit has been developed for this vehicle which consists of thin steel plates fitted around the hull leaving a cavity which is filled with non-inflammable plastic foam. This gives the AML buoyancy with the added advantage that hollow charge shells explode on impact.

Photos: courtesy Panhard

Below: An AML fitted with a 90mm gun turret packs plenty of punch. This version is also equipped with an infra-red searchlight and I.F. headlights for night fighting. The rear-mounted 2-litre engine is aircooled and drives all four wheels through a six forward and one reverse speed gearbox. Top speed is 56mph and the 5.5 ton vehicle has a range of 360 miles on 33 gallons of fuel, or 15 hours endurance in rough battlefield conditions. Like all AMLs it carries perforated spanning plates strapped to its bow which can be bolted together to form bridging over steep-sided ditches.



Above: Sporting an A.A. gun which can give ground fire in short bursts or shot-by-shot, the AML 30 is used for convoy escort missions and for frontier and military installation protection, as well as having a high rate of fire against attacking aircraft.



**ARMOUR  
AT WORK**  
part 7



12p Weekly No. 78 September 12-19, 1975

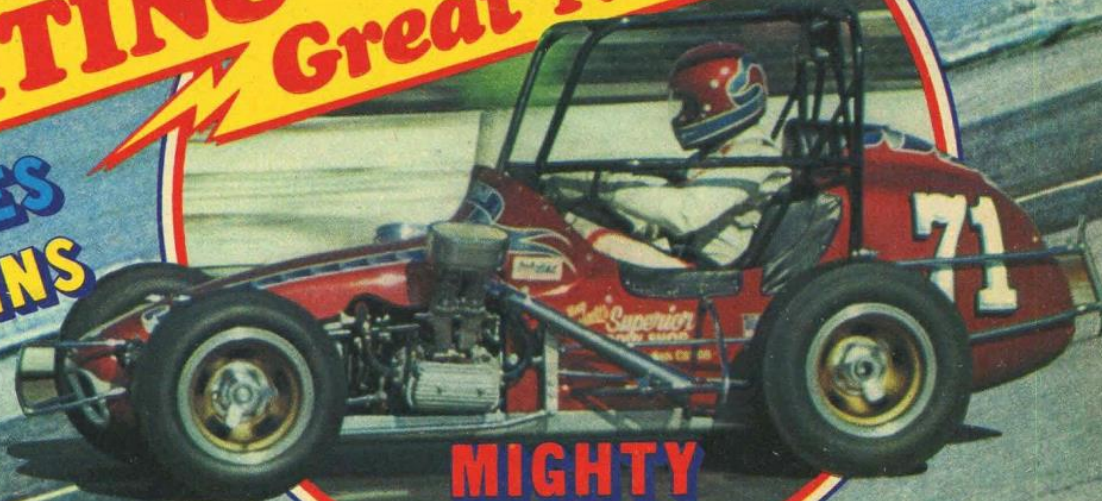
# Speed & Power



**HOVER FROM DOVER!**

**Also Inside.... SHIPS**  
**FIGHTING** Great New Series

**MOTORBIKES**  
**PLANES** **TRAINS**  
**MODELS**



**MIGHTY**  
**MIDGETS**



**Moving house is quite an ordinary sort of thing to do—unless you happen to be taking**

IT'S MOVING day and the scene is the usual one of comings and goings, with slightly anxious owners hovering around and the removal men flexing their muscles for the job ahead of them.

In no time at all, those men are in action, hustling about, shouting instructions to each other and generally rushing about in a flurry of activity. Soon, all is ready and the move is under way, with the vehicle and its load off to a new location.

Yet something strange is happening here. It is not a removal van loaded with furniture that is trundling off, but a contraption carrying—the house itself! The entire structure, with roof, walls, windows and doors, is being transported to a new setting.

One of the most spectacular of such moves took place three years ago, when Ballingdon Hall in

Sudbury, Suffolk, was entirely removed to a new site half a mile away from where it had stood for 350 years. The building had been situated near a main road, and the owners wanted a setting more suitable for such an ancient house.

So they called in the company of Pynford (Southern) Ltd, who are used to such jobs. How did they set about their task? It was not simple, for the journey involved travelling across fields and up a slope of 1 in 10. The first operation, carried out by the builder who would later completely restore the house on its new site, involved the taking out of two large chimney breasts, removal of some brickwork and cleaning out a lot of the interior.

The "removal men" then

prepared for the move, which was to take a team of six men nearly 20 weeks.

Bailey bridge sections were erected around the house to act as a support frame, and then a steel frame was put into the building to form a structure with four sections.

### JACKED UP

Next, the building was jacked up to nearly ten feet above ground level. Sets of four massive 40-ton hydraulic jacks were installed near each corner beneath the main frame, and the jack sets were sited on timber blocks that were raised steadily as the building was slowly raised.

When the required height had been reached, four chassis to take

the transporting wheels were placed, one at each jacking point. Adding up to 26 in all, each wheel was 5ft. 3in. in diameter by 2ft. wide, made up with timber treads on a steel frame.

They were grouped in sets of three or four, to give six wheels at each of three corners of the building and eight at the fourth, to allow for the additional load of the house's rear projection. Each group was arranged to pivot and be adjustable and the two front sets were designed to steer.

To make the actual move, a pair of crawler tractors were used to tow the house over the fields to the new site. That operation took about a week. To avoid disturbing the ground before moving the house into position, the foundations were formed

**the building with you! Here's a moving story**

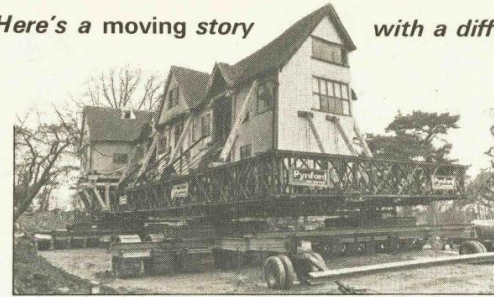
after the move, and the building then lowered onto them.

The methods used in moving houses to new locations are also used to carry out other projects, such as jacking up a roof to allow a new floor to be built beneath it! In this way, buildings can grow in size, saving the owners the trouble of finding bigger new premises.

The idea of moving buildings is not new. As far back as 1906, a building in Chicago had its foundations and piling cut through and was then hoisted up and moved some 100yds. up the street!

Moving houses is not limited to the bigger type of building. A 15-ton capacity telescopic crane recently moved the latest idea in transportable homes. The crane

**with a difference . . .**



**Above: Raised ten feet above the ground, Ballingdon Hall in Suffolk is placed on 26 wheels for its move.**

hoisted the four-ton factory-built Spaceway house, complete with contents, from the back of a lorry onto previously prepared foundations in just a few minutes.

Manufacturers of the house believe that units such as that fully fitted, centrally-heated home, called the Bachelor Pad, could provide an immediately available answer to the acute housing shortage problem in many areas.

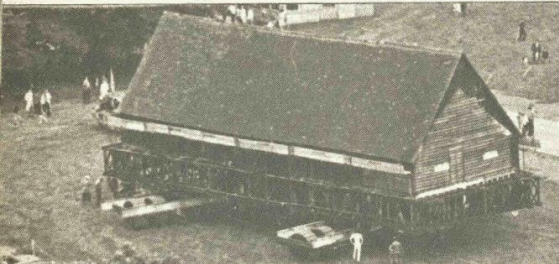
With this system, houses can be produced in a variety of shapes and sizes and rooms added or removed to suit needs. The idea is to make use of the thousands of acres of valuable land lying unused, yet planned for purposes such as road building, and locate the temporary homes for short periods of from two to five years. At the end of that time the houses are moved to another plot.

At any rate, if you see a house cruising past your window one morning it won't be a dream—it will be someone simply moving house!

# MOVING HOME



**Left: "And we'll put this one here" An old semi-detached house becomes completely detached and takes a laborious stroll down a high street in Exeter, Devon.**



**Right: Moving the 380 year-old mansion Ballingdon Hall. Two tractors heave the 170-ton building inch by inch. The two front sets of giant wheels "steered" the house in the right direction, and the half-mile crawl took one week to complete!**





## CROSSING THE CHANNEL PART I

British Rail have different exciting ways to take you across the English Channel.

SPEED & POWER tried two of them.

Here, Assistant Editor Ray Bonds goes on a...

# HOLIDAY HOVER

**T**O STAND and watch a giant passenger hovercraft "take-off" is to witness a display of great power harnessed to Man's comfort and needs. To travel in one—to be borne across the busy English Channel at the start of a Continental holiday—is a thrill not to be missed.

There's no other vehicle quite like a hovercraft—and British Rail's Seaspeed cross-Channel services from Dover have shown it to be the fastest, most convenient way to travel to and from Calais and Boulogne on the French coast.

On their all-year-round Seaspeed services British Rail operate two 190-ton Mount-batten SRN4-class hovercraft—far and away the biggest amphibious hovercraft in the world. Each can carry over 250 passengers and crew, plus 30 cars or two large coaches and cars.

As I sat behind the skipper in the cockpit, or control cabin, of "The Princess Anne", I could feel rather than hear the tremendous power of her four gas turbine engines. You see, I was wearing a communications "headset", listening in to Flight Commander Ian Dalziel's pre-flight checks with his crew and the flight controller in the "control tower" at Dover.

The flight deck instrument layout is similar to those in the Britannia airliner and the beautiful Princess flying boat. There are more than 116 dials plus 70 to 80 switches—and the pre-flight check is carried out before every trip.

At the skipper's command, the

mighty engines lifted the huge hovercraft straight up, about 10 feet on its flexible rubber skirt. Incredibly, the craft is much, much heavier than supersonic Concorde, which needs quite a few hundred yards in which to get airborne!

As we slid away from Dover's famous white cliffs, we could feel the 25-knot (almost 30mph) wind pushing us toward Boulogne. That was lucky, you might think, but Ian Dalziel and his colleagues were already working out the best route to take to avoid the choppy waves they knew would have been whipped-up mid-Channel by that wind. It wasn't so bad going cruising down-wind at close on

60mph—but coming back was sure to be bumpy.

While they were concerned about their passengers' comfort, I was thinking that when it gets rough there must be quite a strain on the flight crew. The noise and vibration are at least double that experienced by an aircraft crew. The hovercraft flight crew complete about three round trips in 24 hours, and this can be very tiring. Therefore, they mix up the round trips a bit so that they do, say, 25 in a five-day week (that's still 50 landings and take-offs), and special seats are fitted on the flight deck, costing almost £1,000 each, to reduce back-ache.

"Hovercraft are very safe," said Ian Dalziel. "It would need five-and-a-half times its own weight on top of it to sink the SRN4, because of its tremendous

reserve buoyancy built in cells around the craft.

"After 20 years in ships and about eight years on hovercraft, I know which one I prefer to travel in!"

As I left the flight deck I noticed the navigator's sophisticated equipment, which includes radars that give a range of 96 miles across the screen. At sea the navigator works to a range of three to six miles, and the radar can "pick up" buoys and small boats, and even sea birds floating on wave-tops.

In good visibility, any hazard shown on the radar can be seen in good time from the high-up flight deck. In an emergency the SRN4 going at high speed can stop in only 250 yards, whereas a Channel ferry ship would need about 800 yards. Because of these good "brakes" the hovercraft can keep up a good speed through the busy shipping lanes.

I climbed down the flight crew's ladder on to the car deck, to be confronted by a weird sight. It was quite noisy, and there were four lanes of empty cars shackled to the deck, all facing the same way and jouncing along like ghostly driverless cars in a motorway traffic jam.

Stepping through one of the side doors into the passenger accommodation, I shut most of the noise behind me. Having in mind 250-odd passengers, I didn't expect to see the cabins so roomy. There are interior lounges—bright, light and clean—but I preferred the outer ones where

CUTAWAY DRAWING ON PAGE 26



Left: Passengers board British Rail Seaspeed's "The Princess Margaret" at Dover. One of two Seaspeed craft, she can carry about 250 passengers, plus purserettes and crew. Right: There's plenty of room between the passenger cabins for up to 30 cars, or two coaches and cars. The car deck floor is strengthened down the centre to withstand the weight of coaches and other heavy loads.



Left: Look closely and you can see that this unusual photo, taken at Dover hoverport, shows four Seaspeed services at once. Not often together on the same pad are the huge SRN4s "The Princess Margaret" (foreground, unloading from the rear ramp) and "The Princess Anne". Tucked in behind her is a tiny visitor, one of Seaspeed's SRN6 hovercraft, which does the Southampton to Cowes, Isle of Wight, run and also charter ferries, such as during the Open Golf Championship at Carnoustie, Scotland earlier this summer. Before taking the big SRN4s across the Channel on scheduled flights, all Seaspeed pilots have to complete 1,000 hours in the smaller SRN6 craft. Just above the nose of "The Princess Anne" you can see the funnel of a Seaspeed ferry ship.



Left: Cars can be loaded from front or rear of the hovercraft. Right: the SRN4 is 130ft. 2in. long, 78ft. wide and has four Rolls Royce gas turbine engines (plus auxiliaries) driving four massive props.

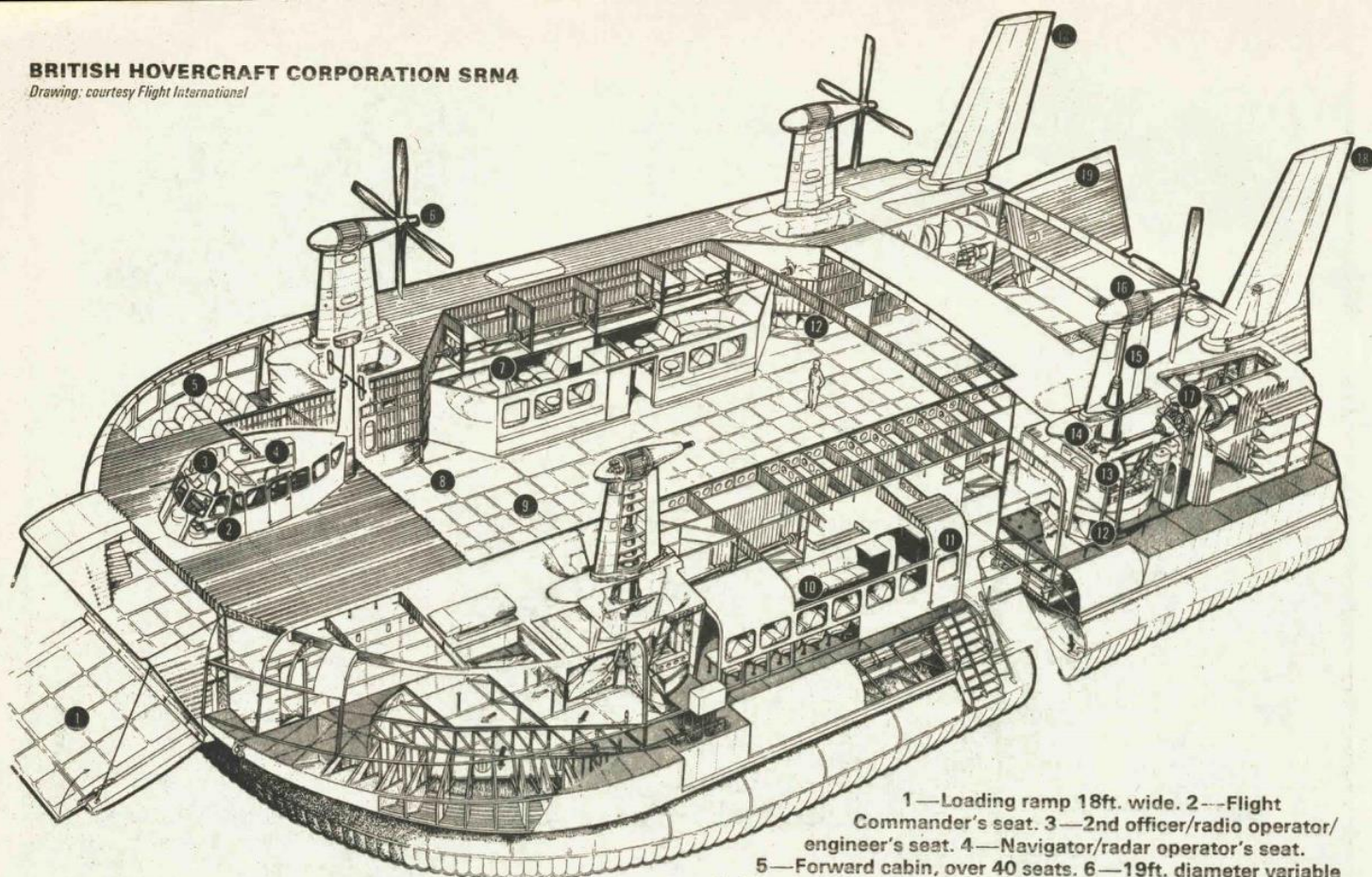


Below: Leaving Dover's slipway, "The Princess Margaret" will soon reach her maximum permitted service speed of 73mph. That's really going, but in calm test conditions the SRN4 can hurtle along at close on 80mph!



Photos: courtesy British Rail Seaspeed





- 1—Loading ramp 18ft. wide. 2—Flight Commander's seat. 3—2nd officer/radio operator/engineer's seat. 4—Navigator/radar operator's seat. 5—Forward cabin, over 40 seats. 6—19ft. diameter variable pitch, reversible propellers. 7—Inner cabin, about 40 seats. 8—Car deck. 9—16ft. wide reinforced coach deck. 10—Side cabin with over 40 airliner-style seats. 11—Passenger entry door. 12—Twelve-blade 11ft. 6in. diameter fan. 13—Fan drive shaft. 14—Gearbox. 15—Propeller drive shaft. 16—Propeller gearbox. 17—One of four Rolls Royce Marine Proteus gas turbine engines, of 3,400 shaft hp each. 18—Rudder and fin. 19—Rear doors, maximum aperture 32ft. by 12ft. 6in.

you can take advantage of the exciting views through large windows of other Channel craft drifting by without hope of matching the hovercraft's speed.

Attractive stewardesses (or, more correctly, purserettes) attended, always with a smile, to passengers' needs at their airliner-type seats. They had to work fast, too, for our journey time was only 34 minutes, including take-off and landing!

Yes, here we were, hovering up onto French soil, just over half-an-hour from departure, and soon happy holidaymakers' cars rolled down the nose-ramp, their places being taken on the car deck by sun-tanned travellers wondering what kind of trip they would have.

Only 18 minutes after "touch-down", we were off again, the smell of Boulogne's fish factory lingering awhile in our nostrils.

Thinking again of the passengers, the flight crew worked out that the most comfortable way to go back into the teeth of a high wind and 8ft. seas was to avoid them as long as possible, hug the French coast as far as Cap Gris-Nez and shoot straight across the Channel to Dover. Many hovercraft veterans think that the shorter route would be a good one to run permanently, with a new hoverport just east of Dover and one between Calais and Boulogne. It would mean just 20 straight-forward miles to sprint across.

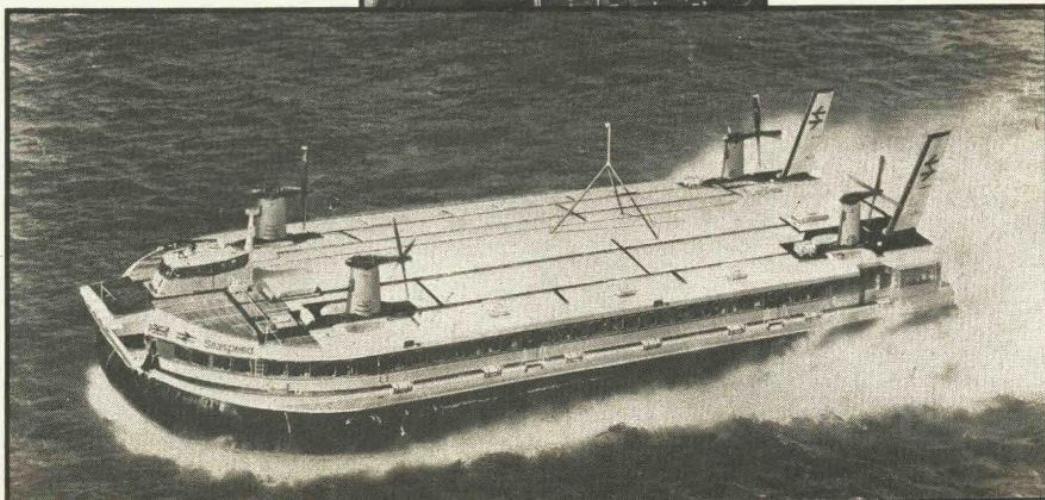
British Hovercraft Corporation, makers of the SRN4, want to build bigger craft (which could

probably do that 20-mile crossing in under 25 minutes). These, called BH88s, would be bigger than the SRN4s, carrying 400 passengers and 59 cars. They would be quieter, need less power than today's craft, and be more comfortable for both crew and passengers because of better seakeeping qualities. BH88s could be in service in time for the 1981 summer season.

The two Seaspeed craft operating now could be "stretched" (a 50ft. section added to the centre). The first conversion could be carried out this winter, to allow another 150 more passengers and almost 30 more cars to be carried quicker and in greater comfort across the English Channel.



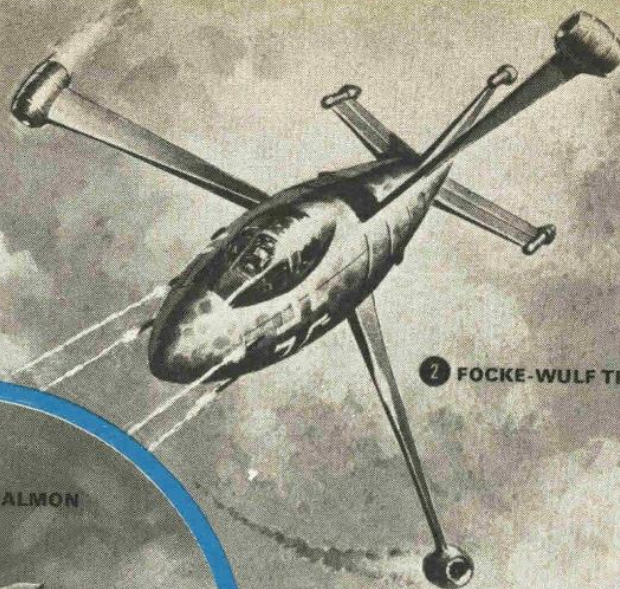
Left: The airliner-like cockpit of the SRN4 hovercraft. Perched at the top of the craft the crew have good visibility all round. Below: An artist's impression of a "stretched" SRN4, a plan which would add 50 feet to its length and enable it to carry 150 more passengers and nearly 30 more cars.



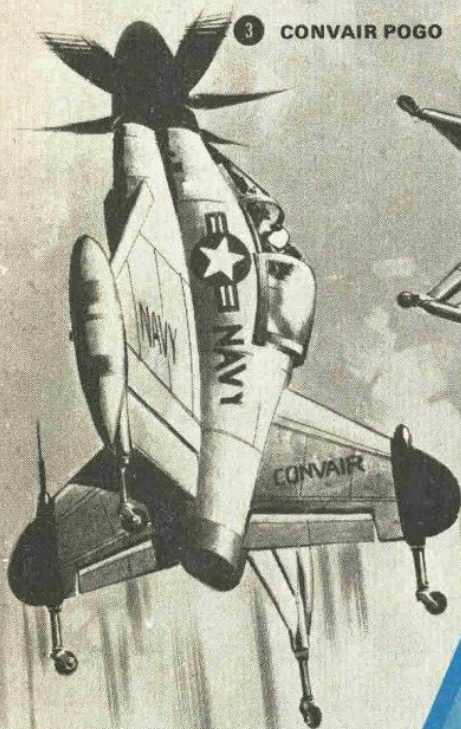




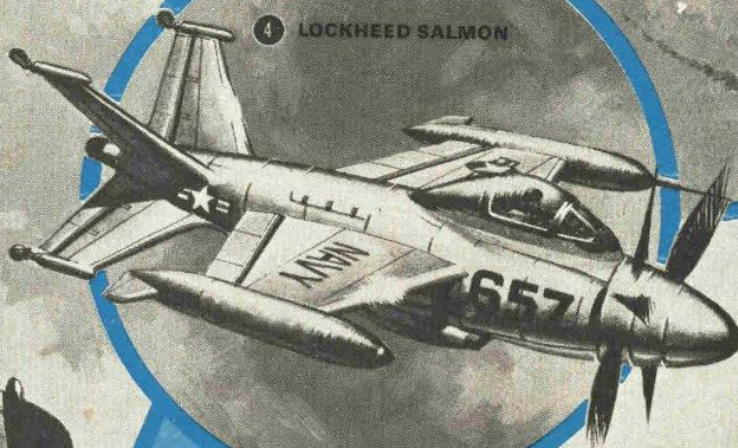
1 HS HARRIER



2 FOCKE-WULF TRIEBFLÜGEL



3 CONVAIR POGO



4 LOCKHEED SALMON



5 SNECMA COLEOPTERE

## New Series Strange sights in the sky

Part 1

# Up and at 'em!

**A**LTHOUGH it is only recently that science has made the vertical take-off fighter a reality, ideas for such aircraft are not so new. During World War II the German Focke-Wulf company produced a design called the Triebflügel. This amazing aeroplane stood on its tail with its nose pointing skywards, and "screwed" its way into the air using a three-blade rotor which revolved around the fuselage, driven by three ramjet engines at the blade tips.

Although this extraordinary machine was not built, other "tail-sitters" have taken to the air. Two such aircraft, the Convair XFV-1 "Pogo" and the Lockheed XFV-1 Salmon, were built in 1953 for American Navy trials. Both had a massive

six-blade contra-rotating propeller driven by an Allison XT40-A-6 turboprop.

The "Pogo" had a delta wing and large fins above and below the fuselage. Castoring wheels were fitted so that it could stand on its tail. The Lockheed design had straight wings with large tip tanks, and the wheels were mounted in the tips of the X-shaped tail surfaces.

### FREE LIFT OFF

"Pogo" made its first free vertical take-off on August 1, 1954, but it was not until another test flight in October that it "converted" to level flight. Altogether it flew about 40 hours.

The Salmon was tested with a temporary undercarriage fitted

to make ordinary take-offs possible. It flew in this way and did convert to hovering flight, but never made a vertical take-off. Both designs were abandoned.

Four years later the French SNECMA company produced a jet-powered tail-sitter, the C-450 Coléoptère. Powered by an Atar E5V turbojet, the strange Coléoptère featured an unusual "annular" wing, which completely encircled the fuselage! Four swivelling fins and castoring wheels were fitted.

On April 17, 1959, the first vertical take-off and landing was made, and it was hoped that a level speed of 497mph would be achieved. Shortly afterwards, however, the aircraft was totally destroyed after the pilot had to eject.

**1. Most successful "straight up" aircraft yet is the famous Hawker Siddeley Harrier jump jet.**

**2. Focke-Wulf "corkscrew" fighter of WWII, which would have had rotating "wings" with jets at each tip for power and manoeuvrability.**

**3. The neat-looking Convair Pogo made a series of useful test flights and took off vertically without trouble.**

**4. Although it flew, the Lockheed Salmon was unable to make a vertical lift off during its trials programme.**

**5. Like a flying barrel, the jet-powered French Coléoptère had a completely circular wing!**



12p Weekly No. 79 September 19-26, 1975

# Speed

## & Power

PLANES  
MOTOR BIKES  
TRAINS  
SHIPS  
CARS

We drive the  
**MAGNIFICENT MASERATI**

Disaster at sea  
**FLOATING FIRE  
BOMB!**





# WERE OUR SPACEMEN ANCESTORS?

Has Earth been visited by beings from other planets, creatures who could have assumed a humanoid appearance? Were the Pyramids built by alien stone circles of ancient times built by alien beings from outside our solar system, who had become marooned on Earth, light years away from their own world? **JOHN DONNELLY**, writer and artist, looks at the evidence supporting these fantastic theories...



in the shape of the well-known White Horses. The largest of Britain's huge images cut out of the ground is a human figure, the 226ft. "Long Man" of East Sussex.

In the South American Nazca Desert near the Peruvian capital, Lima, there are huge geometric designs of plants and animals covering many square miles.

Some markings extend over five miles in length. They are meaningless to someone walking at ground level. Full realisation of their existence only came with the advent of the aeroplane, when from the vantage point of several thousand feet, the pictures could really be seen in their entirety and make sense.

It's difficult to imagine how these designs could possibly have been created without some form of aerial distancing and control by the designers.

Another example of this occurs in Northern France

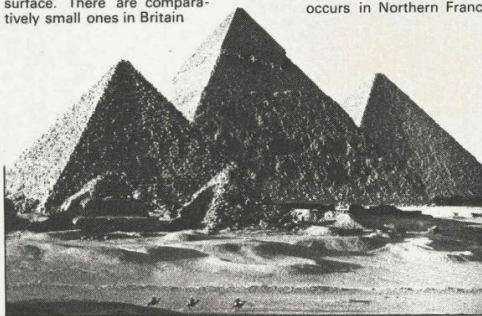
France where apparently random sarsens can be seen from the air to be converging in long straight lines miles through the countryside (converging, incidentally, towards Stonehenge).

There are many similar structures in the Netherlands, Scandinavia, Portugal, Spain and the whole Mediterranean basin. Many thousands remain in N. Africa and extend eastward to India, the Malay Archipelago, Korea and Japan.

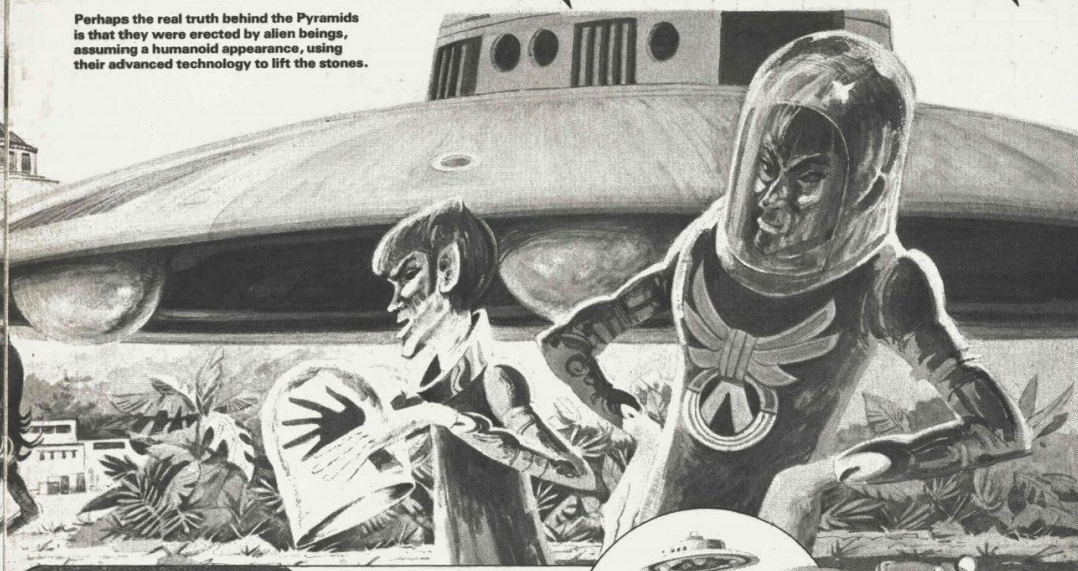
Could they have been aerial distress signals, but on an enormous scale? Proof that marooned alien beings hoped for some chance rescue from the skies? But a rescue by whom and from what?

Before we move on to that possibility let us look at some final clues seemingly unrelated to this theory and to each other, but when considered together suggest an amazing possibility. There are the two deep-frozen Mammoths recovered complete from the Siberian glaciers of Russia, just before World War II.

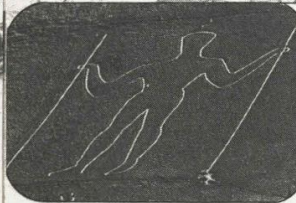
**Left: Can we really believe that, thousands of years ago, Man had the technology, the architectural knowledge to design and build (without today's advanced lifting equipment) the massive Pyramids in the Nile delta? Or that the ancient druids of Britain knew enough about geometry and the positions of sun and moon to drag the 45-ton slabs (right) and erect them in perfect order to form Stonehenge?**



Perhaps the real truth behind the Pyramids is that they were erected by alien beings, assuming a humanoid appearance, using their advanced technology to lift the stones.



**Left: The "Long Man" of Sussex is just one of the designs carved on the Earth's surface and only fully seen from a distance or by plane!**



prevent decomposition. Could they have been slaughtered by some unknown technology?

It is an undisputed fact that the prehistoric dinosaurs disappeared from our planet suddenly, entirely and inexplicably, and a significant feature of dinosaur fossil recovery is that they are invariably found in groups. In Belgium, seventeen were found in one great interlocked mass. Could it be indicative of mass execution, a deliberate and massive extermination of this type of life?



**Left: Some fantastic lowering of temperature, beyond even Nature's power, froze these Mammoths to death. But something—or someone—did: beings from outer space, perhaps?**

## PAINTINGS

They were perfectly preserved down to their stomach contents of grass and foliage. So perfectly preserved in fact that part of the great head of one of them, which had emerged from the ice, was being eaten by wolves when the hunter who made the find stumbled across them.

The curious thing is that Soviet scientists discovered, on analysing the carcasses, that a fantastic, instantaneous lowering of temperature, beyond anything occurring in nature, must have taken place to freeze the great beasts entirely through and thus

Then there are the fabulous cave paintings found throughout the world, of which the ones at Altamira Santander are a good example. They show an incredible

sensitivity and skill.

An attempt has been made to explain them by suggesting they could be typical drawings by primitive, simple cavemen, but the paintings are of such a high standard as to make them almost certainly the work of a



very advanced and sophisticated culture indeed.

But why are they located deep in almost inaccessible caves? Perhaps they were trying to survive some great calamity or disaster that was overtaking a highly organised people. But why no language graffiti? Could they have been so advanced as to have moved beyond the visual depiction of language?

Next week we will look at some more evidence which suggests that our planet was once visited by intelligent beings from outer space.

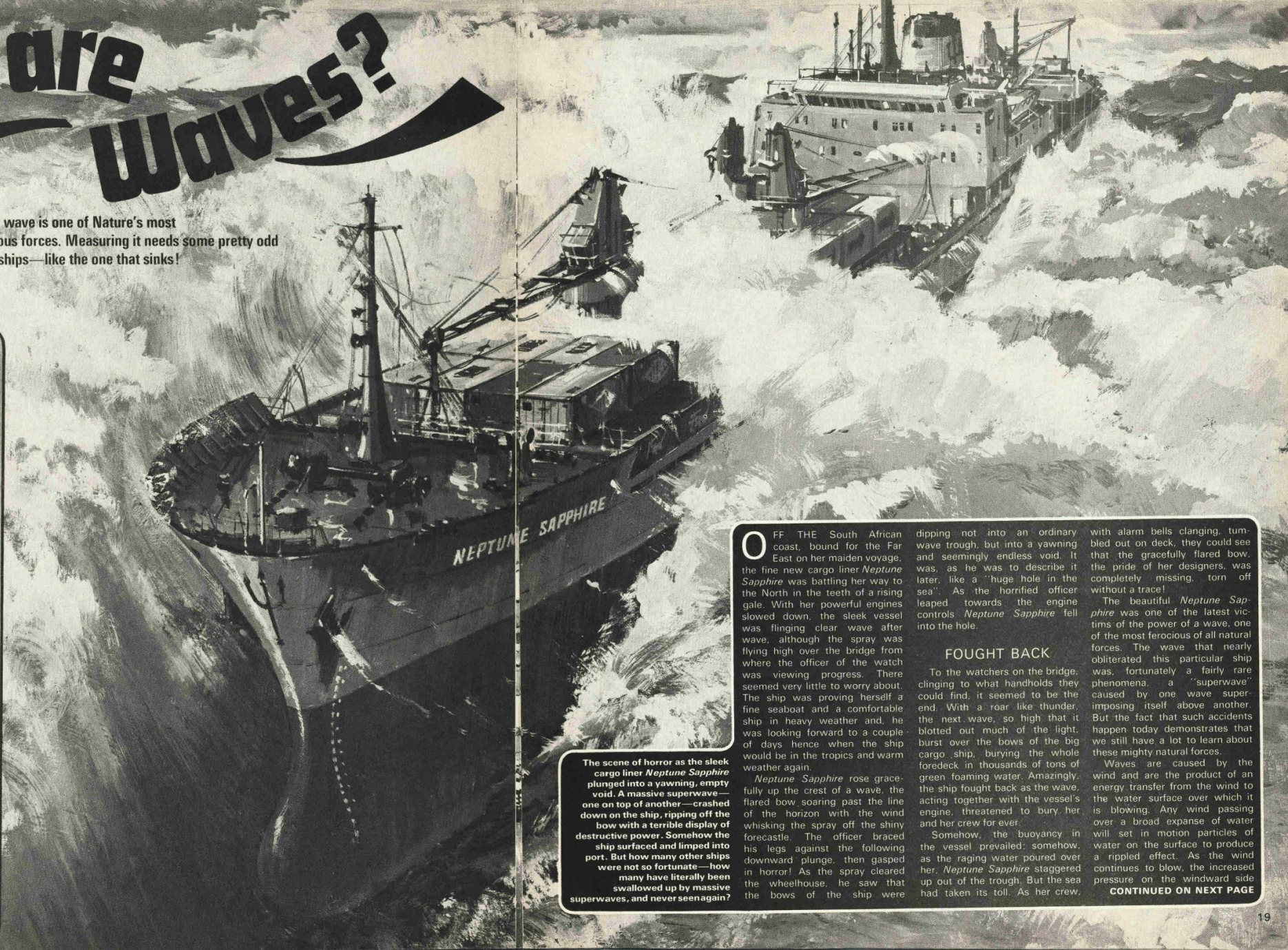
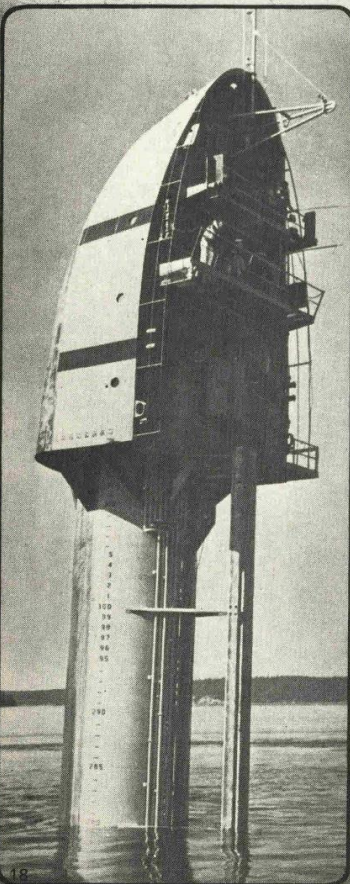
We will examine the incredible theory that the way the ancient Egyptians mummified their dead began as a result of a practice started by a people who knew and experimented with suspended animation—a way of preserving life by slowing it down.



# What are Waves?

The power of a wave is one of Nature's most ferocious forces. Measuring it needs some pretty odd ships—like the one that sinks!

One of the oddest ships afloat is *FLIP* (short for Floating Instrument Platform), shown vertical here with some of its six-man crew. Most of the vessel is below the water.



The scene of horror as the sleek cargo liner *Neptune Sapphire* plunged into a yawning, empty void. A massive superwave—one on top of another—crashed down on the ship, ripping off the bow with a terrible display of destructive power. Somehow the ship surfaced and limped into port. But how many other ships were not so fortunate—how many have literally been swallowed up by massive superwaves, and never seen again?

OFF THE South African coast, bound for the Far East on her maiden voyage, the fine new cargo liner *Neptune Sapphire* was battling her way to the North in the teeth of a rising gale. With her powerful engines slowed down, the sleek vessel was flinging clear wave after wave, although the spray was flying high over the bridge from where the officer of the watch was viewing progress. There seemed very little to worry about. The ship was proving herself a fine seaboat and a comfortable ship in heavy weather and, he was looking forward to a couple of days hence when the ship would be in the tropics and warm weather again.

*Neptune Sapphire* rose gracefully up the crest of a wave, the flared bow soaring past the line of the horizon with the wind whisking the spray off the shiny forecastle. The officer braced his legs against the following downward plunge, then gasped in horror! As the spray cleared up out of the trough, But the sea had taken its toll. As her crew,

dipping not into an ordinary wave trough, but into a yawning and seemingly endless void. It was, as he was to describe it later, like a "huge hole in the sea". As the horrified officer leaped towards the engine controls *Neptune Sapphire* fell into the hole.

## FOUGHT BACK

To the watchers on the bridge, clinging to what handholds they could find, it seemed to be the end. With a roar like thunder, the next wave, so high that it blotted out much of the light, burst over the bows of the big cargo ship, burying the whole foredeck in thousands of tons of green foaming water. Amazingly, the ship fought back as the wave, acting together with the vessel's engine, threatened to bury her, and her crew for ever.

Somehow, the buoyancy in the vessel prevailed; somehow, as the raging water poured over her, *Neptune Sapphire* staggered up out of the trough. But the sea had taken its toll. As her crew,

with alarm bells clanging, tumbled out on deck, they could see that the gracefully flared bow, the pride of her designers, was completely missing, torn off without a trace!

The beautiful *Neptune Sapphire* was one of the latest victims of the power of a wave, one of the most ferocious of all natural forces. The wave that nearly obliterated this particular ship was, fortunately a fairly rare phenomena, a "superwave" caused by one wave superimposing itself above another. But the fact that such accidents happen today demonstrates that we still have a lot to learn about these mighty natural forces.

Waves are caused by the wind and are the product of an energy transfer from the wind to the water surface over which it is blowing. Any wind passing over a broad expanse of water will set in motion particles of water on the surface to produce a rippled effect. As the wind continues to blow, the increased pressure on the windward side

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# What are Waves?

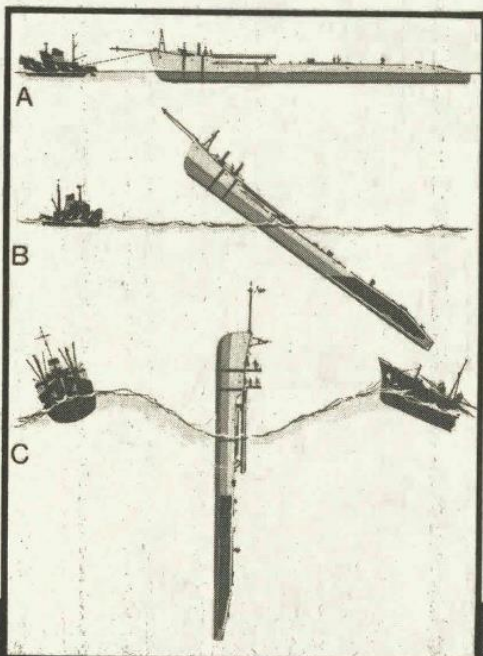
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of the ripple will cause a depression in the water to become deeper, while the lower pressure on the other side of the ripple will help to heap the water up on this side.

As the wind persists, the wave will grow, the wind continually supplying energy to the wave. The wave will continue to grow as long as the wind speed is faster than the wave speed. Luckily, the growth of the wave is limited by a number of things, such as the steepness of the wave which tends to assist in tumbling the tops off the waves in turbulence, or "white horses", which absorb much of the winds' surplus energy.

The depth of the sea and the "fetch", which is the distance that the wave can run before meeting land, is also important in

**How the FLIP ship works. (A) First a tug tows the vessel to its ocean site. (B) FLIP then floods its long aft section with sea water and "flips" to the vertical position. (C) While other ships roll violently in heavy seas, FLIP moves vertically less than one foot. Crew quarters, laboratories and engine room are placed above sea level.**



governing its size. Waves of great height cannot be found in restricted waters, such as bays and lakes, but gales over the deep ocean soon produce enormous waves. Some of the biggest waves to be found in the world occur in the "roaring forties", the great west wind belt which stretches round the world with the tip of South America the sole obstruction.

The highest waves that have ever been recorded have been greater than 100 feet, measured from the bottom of the trough to the top of the crest. However, the actual measurement of waves has always been difficult, largely because of the fact that in very high wave conditions, seamen are rather more interested in keeping afloat than in accurately measuring waves! Also, with a ship rolling, pitching and generally heaving around, accurate observations are particularly difficult.

In an effort to measure waves accurately, so that forces and frequency can be better understood, there have been a number of remarkable craft built. One of these is FLIP, which stands for Floating Instrument Platform, and is a 355-foot long towable ship which can be tipped up into a vertical position to provide a really stable observation platform from which waves can be measured. In waves of forty feet height, which would make conventional oceanographic ships roll violently, FLIP will move vertically less than one foot, providing a comfortable if a little cramped home for her six-man crew.

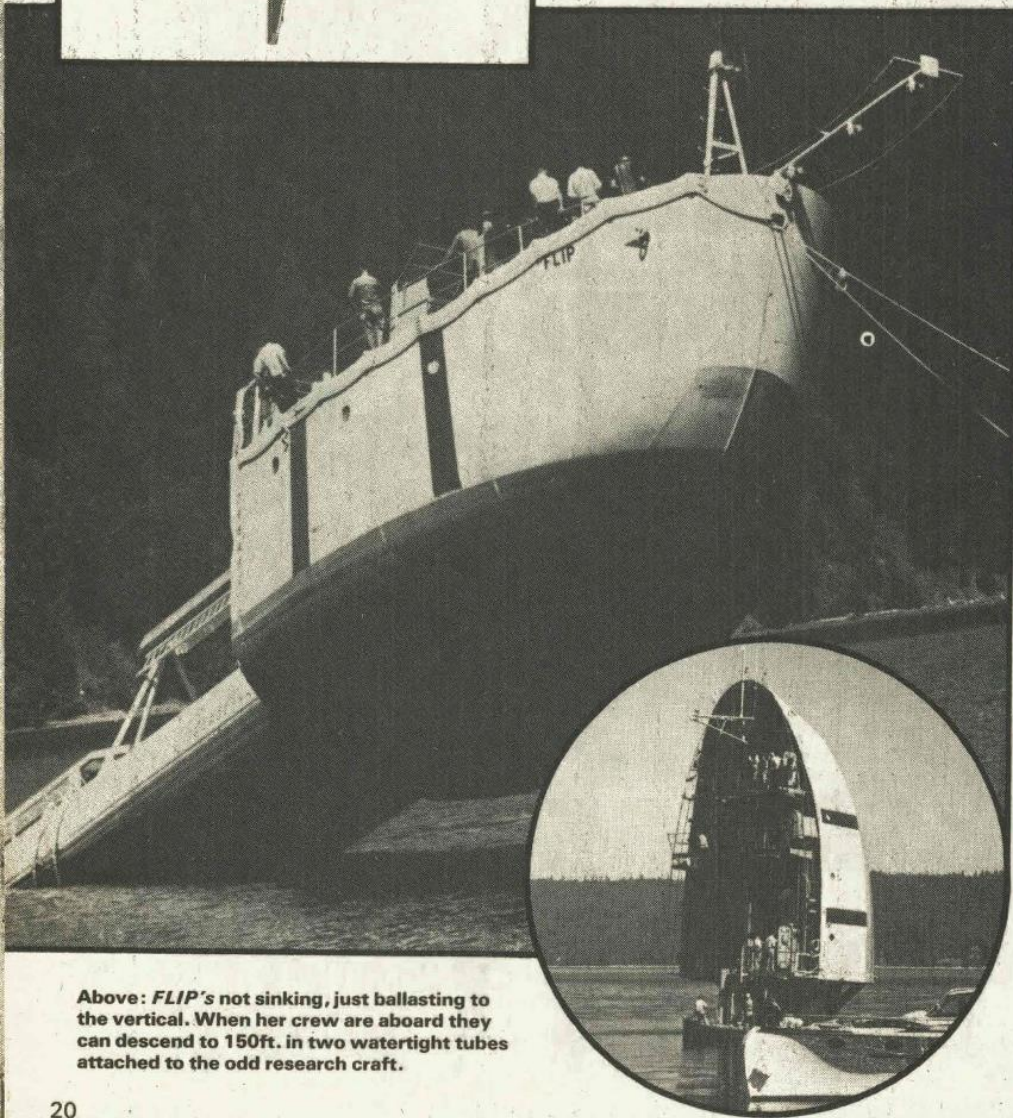
## DESTRUCTIVE

The destructive effect of a wave is caused by its actual power and, with craft like FLIP, it has been possible to measure this power. Actual instrument tests have measured wave forces as large as 6,000 pounds per square foot. Such a wave hitting land would be appallingly destructive but, luckily, ships are able to move with the water forces and can absorb this sort of energy without damage. Coastlines are fortunately spared waves of this power as the shallow water around land tends to modify them somewhat.

In really rough weather at sea, the best place to be is *beneath* it, in a submarine. This is because the maximum vertical motion of the water applies only to the surface layer, and deeper layers of water move less and less. However, most seamen have to make do with surface craft, so the study of waves is very important for their sakes.

## MASSIVE POWER

Naval architects designing ships need to know much more about the massive powers of waves, particularly with craft such as oil rigs which, unlike a ship, have to take all that nature dishes out to them. Armed with information on the size and power of waves, it is possible to reproduce scaled-down waves in test tanks so that ship models can be tried out before the real thing is built. When contending with such powerful natural forces, nothing must be left to chance.



**Above: FLIP's not sinking, just ballasting to the vertical. When her crew are aboard they can descend to 150ft. in two watertight tubes attached to the odd research craft.**



**T**HE IDEA OF having two sets of wings in tandem (one behind the other) goes right back to the early days of aviation. In 1896, Samuel Pierpont Langley flew two large tandem wing models in America, but his two attempts to launch a similar full-size manned aircraft in 1903 met with failure, both of them collapsing as they were catapulted from a houseboat!

In the years that followed, several other tandem wing designs were built and flown in various parts of the world, but undoubtedly the most interesting were two built in Britain by the Miles company during WWII.

Unlike tail-first aircraft, in which the small forward surface acts just like a tailplane, the forward surface of a tandem wing design carries a large share of the aeroplane's weight and provides much of the lift. In addition, the centre of gravity, which is usually beneath the wing of a normal aircraft, is set between the wings in a tandem wing machine, and has a much wider range of movement.

Many of the modified fighter aircraft being used on carriers in 1941 were unsuitable, particularly as their pilots had a very poor forward view for landing. This led to accidents, and George

Miles realised that the tandem wing layout, which allowed a pilot to be seated right in the nose, would solve the problem. In six weeks, a small wooden flying mock-up of a tandem wing carrier fighter, the Miles M.35, was built—without official knowledge or permission! The Miles company gave the name Libellula (Dragonfly) to this and all their later tandem wing designs. Unfortunately, it proved to be unstable and flew only once, the pilot being very anxious to get back to earth in one piece!

However, the Air Ministry had now issued a specification for a high-speed, unarmed bomber,

and a tandem wing design was prepared to meet this need. Once again a small flying mock-up was built. This aircraft, the Miles M.39B, was powered by two 140hp Gipsy Major 1C engines, and flew for the first time on July 22, 1943. This time the aircraft made many test flights.

Neither the carrier fighter or the full-sized bomber were built, but the Miles company continued to produce tandem wing designs for six- and eight-engined bombers, two more fighters and a post-war mailplane with three jet engines in the rear fuselage. None of these was built.

A number of tandem wing aeroplanes have appeared since World War II, the latest being the British Lockspeiser LDA-01. This was designed by David Lockspeiser, an ex-Miles employee. The prototype, which first flew in August 1971, is only 70 per cent full size, but now that it has successfully completed its flight test programme it is hoped that a full-size LDA-1 will soon be airing its wings.

## Strange sights in the sky Part 2

# Tandem Wings

**Left:** One of the most successful Miles projects, all of which were known by the name Dragonfly, was the M.39B, an unarmed bomber with two 140hp engines.

**Right:** Intended for rapid construction in Canada, away from the European war zone, the Miles M.41 was a six-engined transport/bomber designed to carry a 64,000lbs load. Built of wood, its rear wings would have spanned 142 feet. It did not go beyond the project stage, however.

**Above:** The Miles M.35 was the firm's answer to the bad forward vision of most Navy fighters of WWII. Spanning only 20 feet, the little aircraft had a nose cockpit, but flew badly. Below: A modern tandem wing aircraft is the Lockspeiser all-purpose type.

**Left:** Tandem wings date back to 1896, when experiments with this type of aircraft were tried, but proved a dismal failure! Catapulted from the top of a house-boat, a full size, manned aircraft did not perform like tandem wing models built before!





Above: Three drawings showing the Vought V-173 "flying pancake" of 1943. The pilot climbed in order the deep circular wing as the aircraft had a very steep climb angle. On one flight, the flapjack flipped to avoid bullets!



Left: Imagine this heavily armed monster tearing into flimsy Japanese planes in WWII. That was what was intended of the XF5U-1, which had ten guns.

*Strange sights in the sky Part 3*

# The Flying FLAPJACKS

ON November 23, 1943, the chief test pilot of the Chance Vought aircraft company in Connecticut, USA, took one of the strangest aeroplanes ever built for its maiden flight.

The Chance Vought V-173, as it was called, had been developed over a period of ten years by designer Charles H. Zimmerman. Looking more like a propeller-driven pancake than a flying machine, it had been developed by Zimmerman as a small-span aircraft which, he hoped, would have a high top speed and yet be able to hover. At the tips of the circular wing, were two massive propellers which provided a smooth airflow over its whole surface. In hovering flight, it was expected that the aircraft would

be able to hang vertically beneath these enormous "windmills"!

The V-173 was intended only as a full-scale test aircraft to prove the basic flying qualities of the design before a fighter, the VS-315, was built for the US Navy. Altogether the V-173 logged 131 hours in the air, and one of the pilots who flew it was none other than Atlantic pioneer Charles A. Lindbergh. Because of the stinky undercarriage, pilots had to enter the machine through a trap door in its underside.

The "Flapjack" proved impossible to spin or to stall completely. Unfortunately, its two 80hp Continental A-80 engines were not really powerful enough, and partly because of this, it suffered several emergency landings. On one of these, it

force-landed on a beach, and the pilot turned it over trying to avoid a sunbather! This amazing machine could take off within 200ft. in normal conditions, and, in a 25-knot wind, it could go straight up! Its top speed was 130mph, and it was controlled by elevons extending from the wingtips, rudders, and "stability flaps" on the trailing edge.

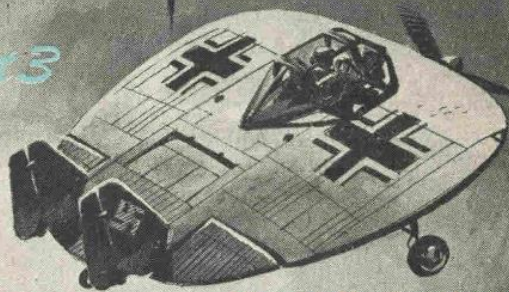
## FIGHTERS BUILT

While the V-173 tests continued, work on the VS-315 proceeded. By now it had been given the official US Navy type number XF5U-1 and two were ordered. More effort was now spent developing propellers which would enable the aircraft to hover. To do this they had to behave rather like

helicopter rotors in some ways. The engines were to be two 1,600hp Pratt & Whitney Twin Wasp radials, buried in the wing either side of the cockpit. It was planned to arm production aircraft with six machine guns or two machine guns and four 20mm cannon.

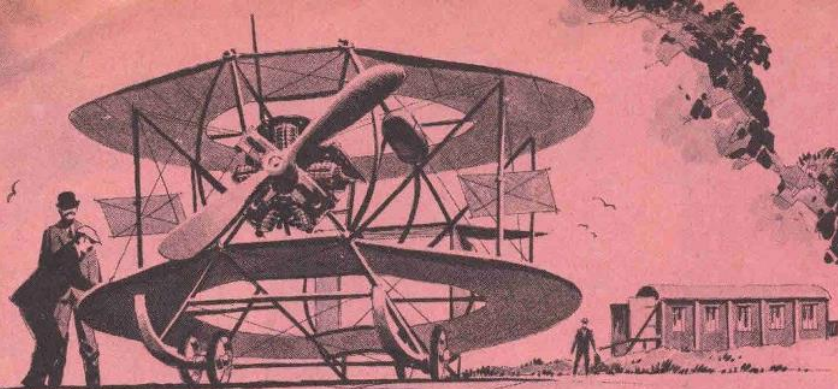
Due to delays in getting the special propellers, the XF5U-1 did not make taxiing tests until 1947. However, money problems and the arrival of the jet age caused the US Navy to cancel development of the aeroplane, and it was scrapped in 1948 without ever leaving the ground.

Fortunately the V-173 escaped destruction, and this airborne pancake is now preserved by the National Air and Space Museum in Washington, DC.

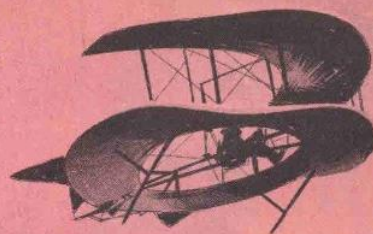


Above: The Germans also tested a "pancake" aeroplane during the war, although only models are believed to have flown.

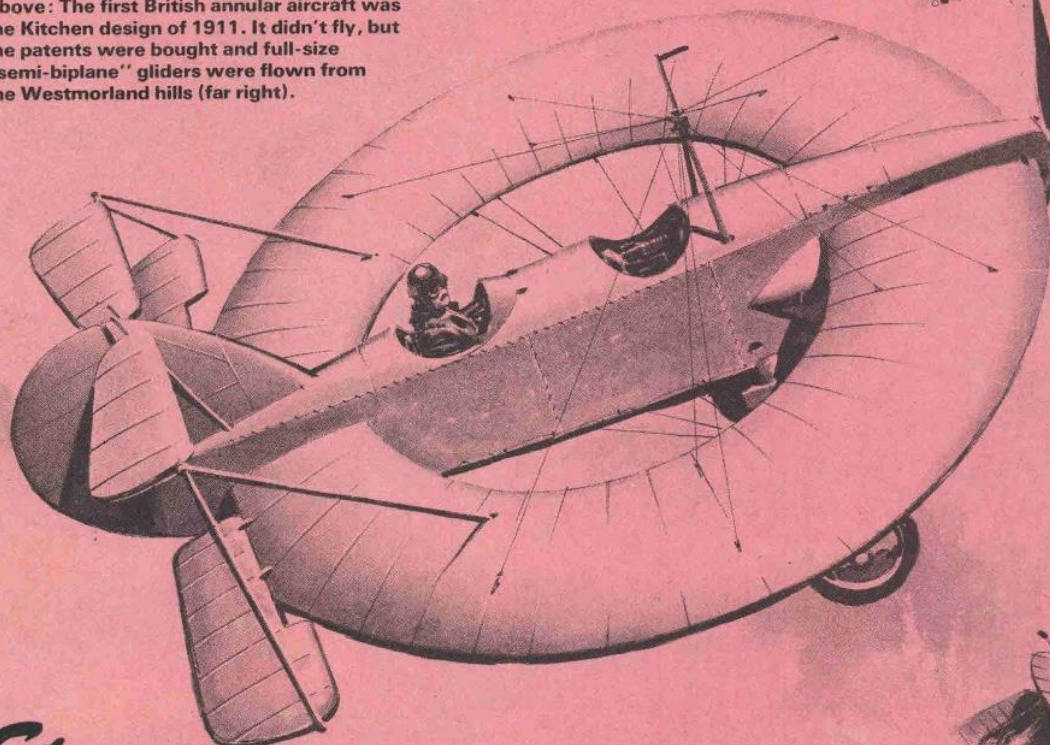




Above: The first British annular aircraft was the Kitchen design of 1911. It didn't fly, but the patents were bought and full-size "semi-biplane" gliders were flown from the Westmorland hills (far right).



Left: Three Lee-Richards annular wing monoplanes were built before WWI and they flew for a total of 128 hours, despite crashes.



Below: When his test pilot went off to war, designer Cedric Lee tried to fly his plane himself, but crashed in a river near the aerodrome. He was not hurt, but annular planes soon became history.



## Strange sights in the sky Part 5 Flying in Circles

*Among the weird flying machines built since Man first took to the air, few were as way out as the "circle wings".*

**B**EFORE World War I, flying machines were an incredible sight to the man in the street, but some designers obviously thought they weren't incredible enough! Many weird and wonderful aeroplanes were built, and a large number of them never left the ground! Of all these machines, perhaps the strangest were the "annular" aircraft, which had ring-shaped, circular wings.

The first annular aeroplanes were built by a German, Fritz Huth, in 1909 and 1910. But although his second aircraft flew, it had a poor performance. In America, William Romme persuaded Harold

McCormick, of the rich harvester family, to finance the building of his "Umbrellaplane", which was completed and flown during 1911-13. Despite determined efforts, however, the Umbrellaplane was also a poor flyer and was abandoned.

British attempts to construct annular aeroplanes met with more success. The first to appear, in 1911, was a biplane designed by G. J. A. Kitchen. This aeroplane was tested at Heysham and failed to fly, but the patents were bought by Mr. Cedric Lee, who, with the help of Mr. G. Tilghman Richards, carried on the work. Three full-size gliders were constructed and flown from

hills in Westmorland. These were really "semi-biplanes", as they had a circular wing with a half-circular wing above!

In 1912 the team moved to London, where detailed wind-tunnel tests were carried out. Work then began at Shoreham on the Lee-Richards annular monoplane, powered by an 80hp Gnome rotary engine. By November 1913 it was ready, and on the 23rd it made its first flight—which was also its last! The aeroplane flew very well until its engine failed, but it then went out of control and crashed.

The design was modified, a new machine was built, and early in

1914 it took to the air. More alterations were made to try and improve control, but at the end of April it crashed again when an elevator broke off in the air!

Yet another circular wing machine was built. This was much more successful, and flew from early 1914 until the outbreak of World War I. At this time the test pilot joined the Royal Flying Corps, so Mr. Lee tried to fly his own aircraft. He ended up upside-down in a river alongside the aerodrome! In spite of all the crashes, not one pilot was seriously injured. In fact, the three machines between them had spent 128 hours in the air and covered about 11,000 flying miles!

Cedric Lee was killed in the war, but Tilghman Richards tried to interest military authorities in annular aircraft when it ended. Unfortunately they did not share his enthusiasm, and circular aeroplanes became just a quaint memory from aviation's colourful pioneering days.



# Fat-winged Fighter

*In an effort to stop stalling of the wing tips of conventional fighters, the XF-91 was born.*

**T**ODAY, WE are all used to the sight of supersonic jet fighters, with their smooth, thin, swept-back wings. However, in the days just after World War II, when designers were not so sure which wing shape was best for fighters equipped with the new jet engines, many strange-looking aeroplanes took to the skies.

One of the oddest of these was the Republic XF-91 Thunderceptor, two of which were ordered for the United States Air Force in 1946 as high altitude interceptors. As rocket engines used too much fuel on their own, the XF-91 was to use jets and rockets combined, but the Thunderceptor's most peculiar feature was its wings. Instead of becoming narrower and thinner at their tips, as on most swept-wing designs, they grew wider and

thicker! This was done so that most of the lift would be created at the wing tips, helping to reduce the wing tip stalling at low speeds which was causing problems.

The whole wing could also be tilted upwards slightly at the front, to enable take-offs and landings to be made at lower speeds!

One new problem created by this extraordinary wing was where to put the undercarriage. Where it joined the fuselage, the wing was so thin that there was no room inside it to house the wheels! Because of this they had to fold up outwards into the thicker tips, and two wheels in tandem had to be used.

The XF-91 made its first flight on May 9, 1949. First of all it was powered only by a General Electric J47-GE-3 jet, with a thrust of 5,200lb. Later, however, four rocket engines were fitted in pairs above and below the jet tailpipe. These added another 6,000lb. of thrust for short periods! In December 1952 one of the two aircraft built became the first American combat aircraft to break the sound barrier in level flight, using the power of its jet and rocket engines together!

Top speed of the XF-91 was 1,126mph at 50,000ft. It could cruise at 539mph, and had a maximum range of 1,171 miles. Unfortunately, it was not ordered into production.

As if the Thunderceptor did not look odd enough already, it could carry an enormous 230-gal. fuel

drop tank beneath each wing. And the last of the aeroplane's good looks disappeared late in its life, when one was fitted with a "vee" or "butterfly" tailplane which did away with the usual fin and rudder.

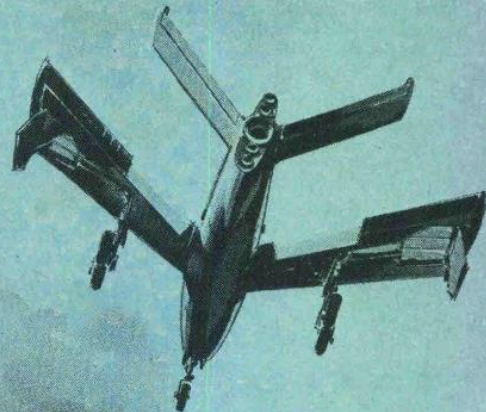
Once they had provided all the useful information they could on high speed flight, the two XF-91s were retired, and one of them now displays its weird wings to visitors at the USAF Museum in Dayton, Ohio.

Right: Here you can see how different the Thunderceptor's wings were from other jet fighters. It first flew in May 1949.



The jet- and rocket-powered XF-91 became the first US military aircraft to crack the sound barrier in December 1952, boosted by nearly 12,000lb. of thrust!

Below: One of the two XF-91s built was fitted with a V-shaped "butterfly" tail unit for stability tests, and this one is now in the US Air Force museum.



The name "Thunderceptor" was chosen for the XF-91 because the Republic firm had used the word "thunder" in the name of previous aircraft and its job was interception.



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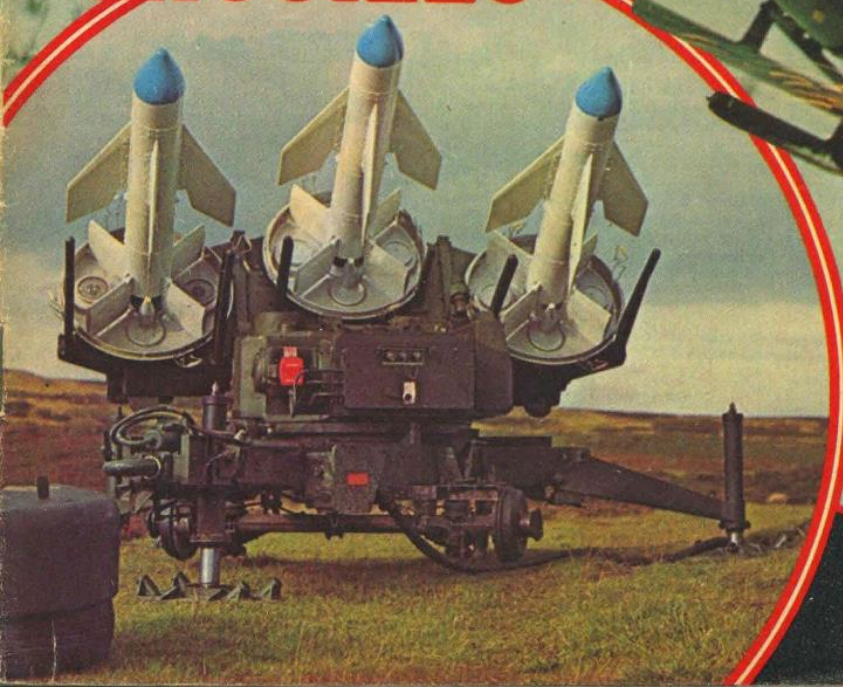
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# **Speed** **& Power**

12p Weekly  
No. 85  
October 31-  
November 7, 1975

**MIGHTY  
MISSILES**



**CARS**  
**SCIENCE FICTION**  
**PLANES SHIPS**  
**SPACE**



# GIGANTIC GUPPY GULPS THE GOODS

Today, most of us are familiar with the mighty Boeing Jumbo Jet; but the same American firm built another Jumbo—a fantastic flying truck known as the Super Guppy—one of the strangest aircraft ever flown

IF YOU HAVE parts of a giant airliner, a big boat, a space missile or a jet fighter to move quickly, how do you do it? Aero Spacelines of America came up with the answer to that one when they took two Boeing Stratocruiser airliners and filled them full of air!

With the US space programme in full swing, an aircraft was needed to carry the huge booster rockets and other oversize items between the factories and launch sites. Known as Guppies, these massive machines were the biggest thing in the skies in those days.

The first job to be done to the Stratocruisers was to stretch the fuselage by nearly 17 feet and fit the circular-section "bubble" over the top of the existing cabin. This gave an inside headroom of up to 19ft. 9in.—double that of the original aircraft.

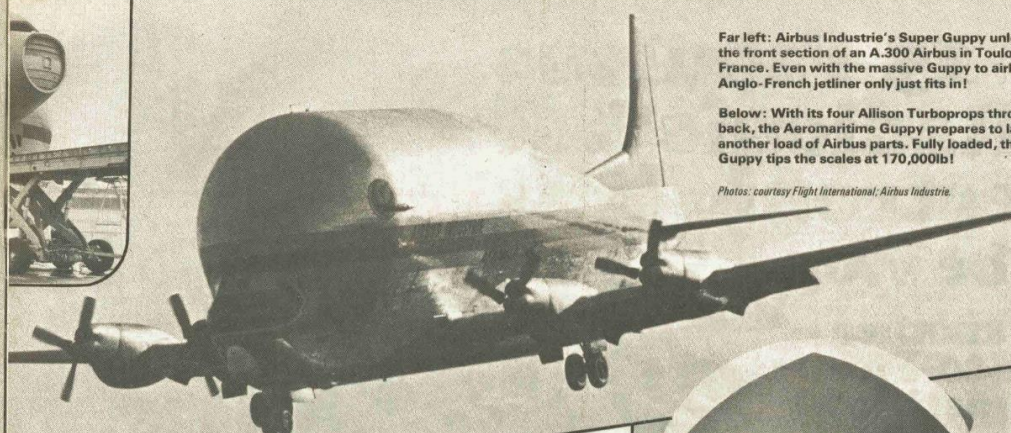
So useful were the Guppies to NASA and other US Government agencies, that Aero Spacelines developed a further model, the Super Guppy. With four Allison turboprops, this one had a swing nose loading section, including the flight deck, to take bulky cargoes on special large pallets. The Super Guppy first flew in August 1965.

This machine also went into service with NASA as a rocket mover, and with the Commercial Super Guppy, other freight loads could be carried. It was a smaller version but still pretty impressive!

One of the most important jobs the Guppies do in America today is to move fuselage sections of the McDonnell Douglas DC-10 and wings of the Lockheed TriStar from the production plants to the final assembly shops. And in Europe, Super Guppies do a similar job transporting parts of the A.300 Airbus from France to England. So, what may look like a flying impossibility saves much valuable time and money when it comes to moving outsize loads by air.



Below: The first Guppies were loaded from the back, with the whole tail wheeled back. A huge missile booster is being slotted in here.



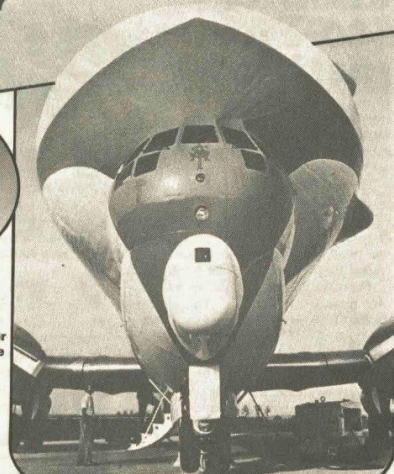
Far left: Airbus Industrie's Super Guppy unloading the front section of an A.300 Airbus in Toulouse, France. Even with the massive Guppy to airlift it, the Anglo-French jetliner only just fits in!

Below: With its four Allison Turboprops throttled back, the Aeromarine Guppy prepares to land with another load of Airbus parts. Fully loaded, the Guppy tips the scales at 170,000lb!

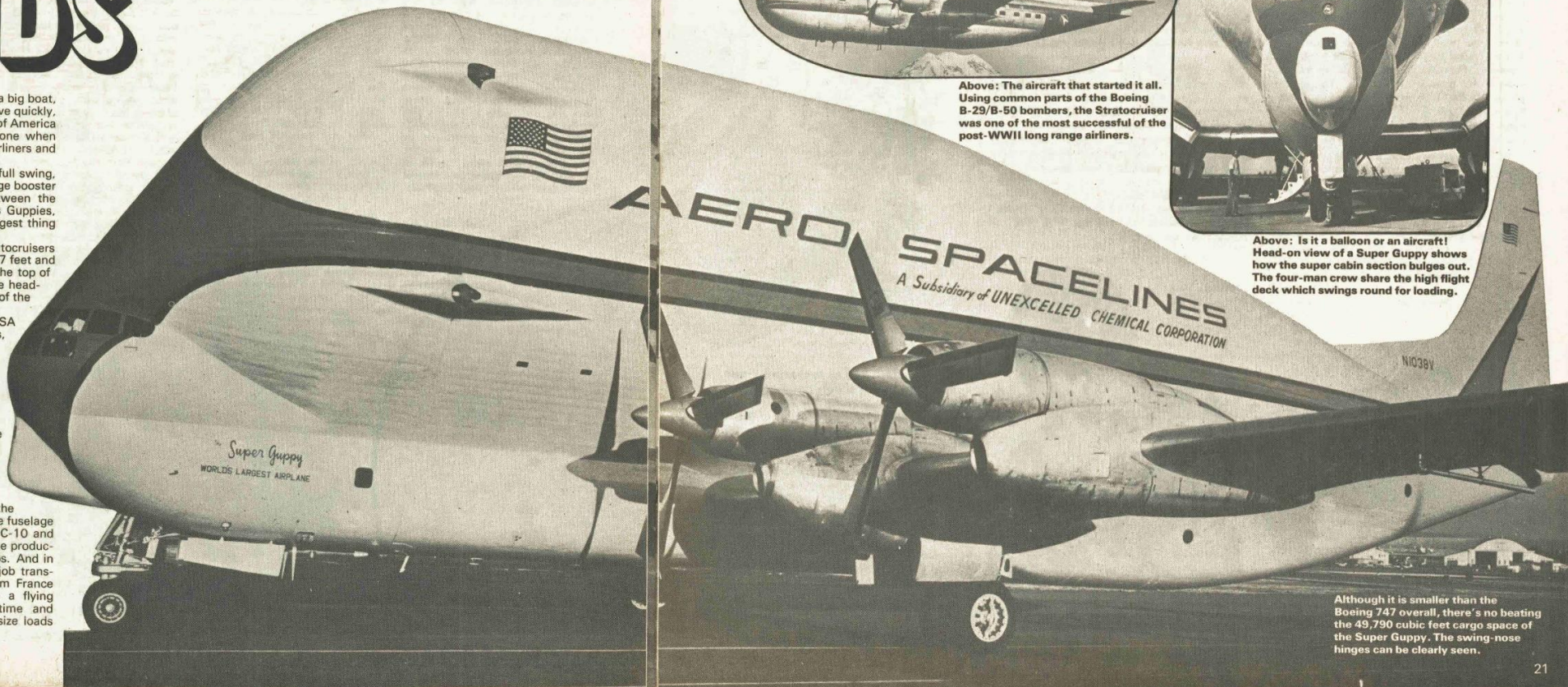
Photos: courtesy Flight International; Airbus Industrie.



Above: The aircraft that started it all. Using common parts of the Boeing B-29/B-50 bombers, the Stratocruiser was one of the most successful of the post-WWII long range airliners.



Above: Is it a balloon or an aircraft! Head-on view of a Super Guppy shows how the super cabin section bulges out. The four-man crew share the high flight deck which swings round for loading.



Although it is smaller than the Boeing 747 overall, there's no beating the 49,790 cubic feet cargo space of the Super Guppy. The swing-nose hinges can be clearly seen.



# ★ WHAT A WIZARD CAR!



Paul Jameson's Merlin-powered six-wheeled wonder car

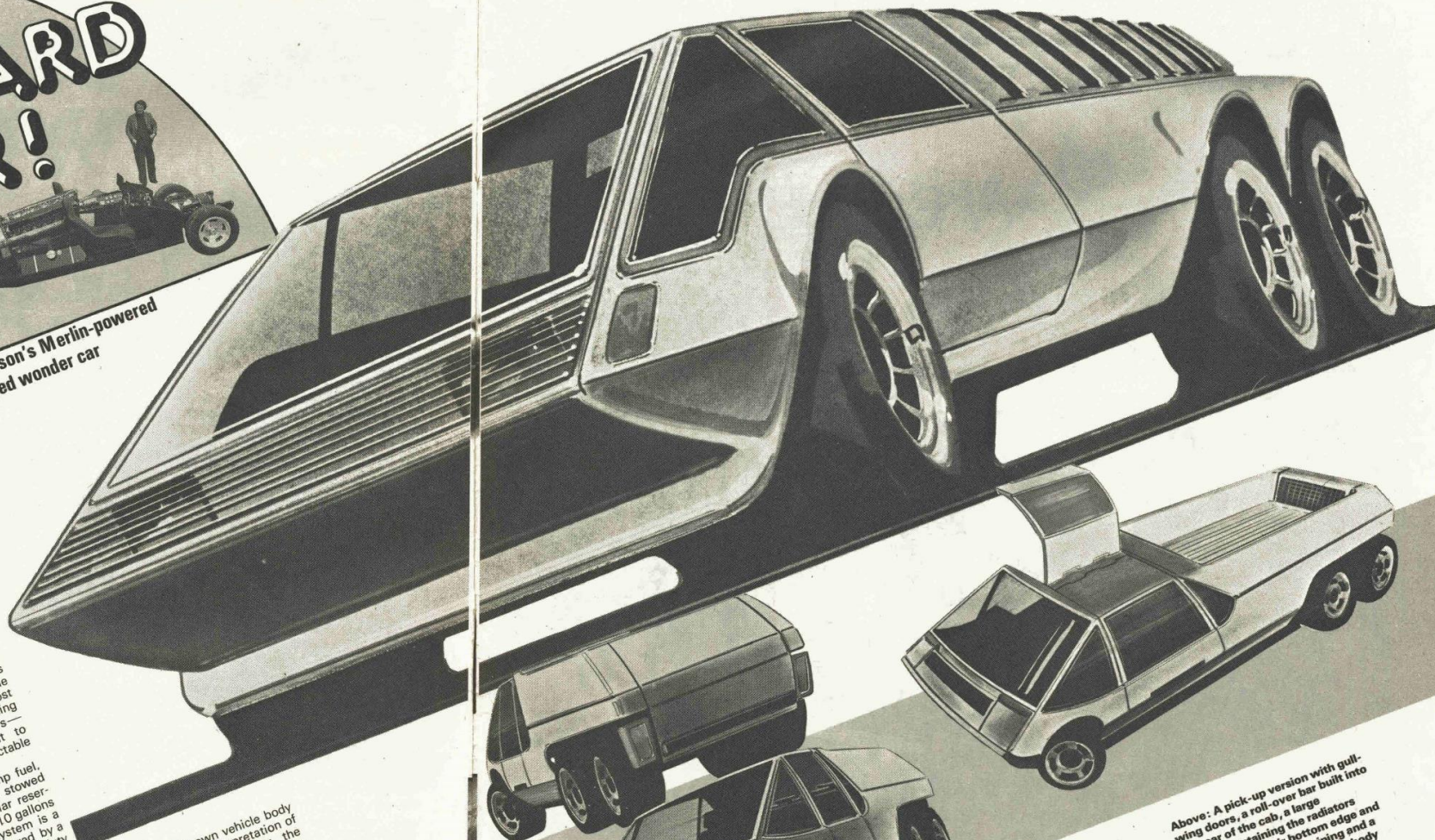
Dominated by the huge exhaust pipes of the 27-litre V12 engine, the chassis of the car is nearly 19 feet long. Two Ford truck radiators and electric fans are needed to keep the beast cool. Photos: courtesy Motor.

THE glistening framework trembled excitedly under the strain of a chilling roar sprang suddenly from the funnel-like exhausts and the monster had two huge plumes of smoke shot skywards. Twitching his toe on the sensitive throttle Paul Jameson inched the giant backwards down his drive. Then with barely a warning rise in engine note the wheels began gently spinning under the effortless torque. This was real power—all 1,760bhp of it—Merlin power—all 1,760bhp of it. Paul's first car was built around a Centurion tank engine, 27-litres of V12 producing a mighty 700bhp. Though this would be sufficient to terrify the most ardent of enthusiasts, Paul was always disappointed. He had not conquered Merlin, one of the all-conquering Centurion's Meteor are capacity, motors instead. Though it and the same family internal differences marked the addition of a centrifugal supercharger on the Merlin give it over twice the power. So you see, Jameson it is quite some project. This time Paul chose to place

the engine amidships, positioning it in the home-made chassis so as to achieve approximately a 50/50 weight not one but two Merlin powerboxes which in turn drive a pair of axles. The automatic gearboxes which the mechanics hope to make their the boxes, hopefully, changes at the same time! Of course Merlins don't rev quite as high as most toy-like units of most modern cars, and flat-out running is limited to a mere 3,000 revs—this, however, is sufficient to propel the giant at a respectable 185mph!

The beast runs on pump fuel, 25 gallons of which are stowed in alloy side-tanks. Similar reservoirs in alloy stow no less than 10 gallons of oil. The electrical system is a 24-volt one and is powered by a pair of rear-mounted heavy-duty batteries. Also astern are the massive Ford truck-style radiators and their accompanying fans that strive to keep the fire-breathing monster. The suspension is all Jaguar. Mk 10 and the Jaguar Range-Rover are operated by brake discs and hydraulics. Steering is a wonderful concoction of MGB joints, four Mini steering columns and a Jaguar power-assisted steering box. So far no specific thoughts have been made on clothing the car.

SPEED & POWER has commissioned a well-known vehicle body stylist to give his interpretation of some suitable bodies for the chassis and his ideas are shown here. If the type of body Paul Jameson finally decides on has approaching the quality of the finished panel work then the finished vehicle will indeed be a handsome beast. So far the beast has only made one excursion from its home, when it was demonstrated to the visitors of an aircraft open-day. Doubtless there, the breathtaking sound of the Merlin did not seem out of place. Hearing it flying down the open road, however, should be something else again!



Without its body the monster weighs 2 tons yet with 1,760bhp on tap, plus another ton of panel work the car would still be capable of 180mph!



The twin rear wheels set so far back and the huge exhaust pipes present a problem when designing a body, but a high speed pick-up truck, suitable for say, transporting racing bikes between European meetings, would be possible if the cooling system was re-routed along the sides.

Above: A pick-up version with gull-wing doors, a roll-over bar built into the rear of the cab, a large tailgate containing the radiators and hinged along their bottom edge and a load-carrying platform-cum-body panel which can be lifted off to reveal the "mechanicals". Other servicing show views of a motorway cruiser and long-distance passenger car.



With buses becoming more and more important in town travel—and drivers getting less and less easy to recruit—the answer for tomorrow may well be buses that drive themselves . . .



# The Bus with NO DRIVER!

**D**ING! DING! Moving off down a crowded high street, and loaded with dozens of passengers carrying children and heavy shopping, the modern bus heads past the Saturday morning traffic in a specially prepared bus lane. Every few hundred yards it stops, there is the usual interchange of passengers through the air-operated doors, and it moves on again.

Quite a normal town centre situation, you may think, but you would be wrong. For, looking at the front of the bus, you will notice that something rather important is missing. The driver! And this could well become a frequent sight in the town centres of tomorrow.

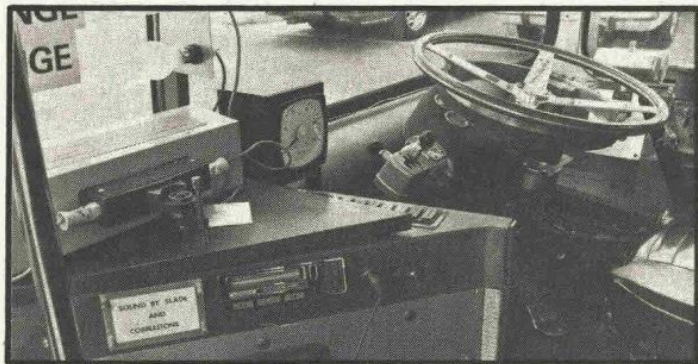
At the Transport and Road Research Laboratory they have been working on a driverless bus

**Above: Guided by a simple underground cable, a driverless bus heads down a busy high street. It stops, starts and accelerates by means of signals received from the buried cable.**

system for some time. The bus uses a simple guidance system—basically a cable buried under the road. Using this, the bus will steer or stop and start according to electronic "orders" programmed into the cable.

This cable can even be laid on the road surface as part of the white line! Special sensing devices underneath the bus would keep it either in the centre, or to one side, of the white line. If any object, or a pedestrian, stepped in the vehicle's path, a form of radar mounted on the front would automatically apply the air brakes.

**CONTINUED ON NEXT PAGE**



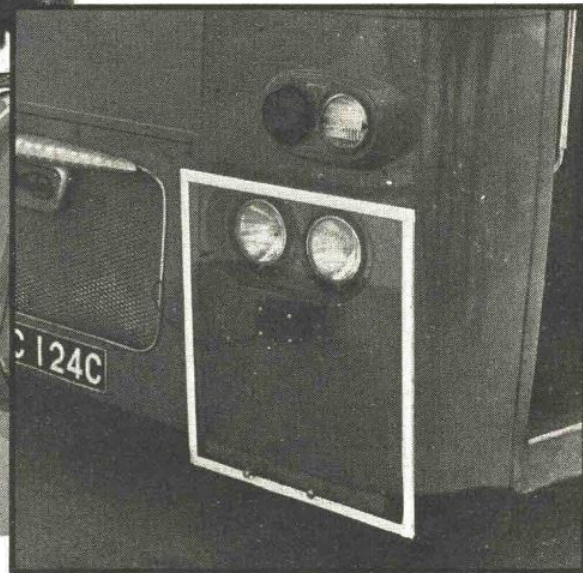
Some of the new equipment fitted inside the experimental bus. Notice that the ordinary controls are still there for manual operation.





Left: It's certainly a strange sight—a crowded bus bowling along with no driver up front! But the passengers don't look too worried. They obviously know about the extensive safety systems that are fitted, and about the bus's radar which will stop the vehicle if there is something in its path.

Below: These strange panels on the front of the experimental bus are used to pick up signals from the guiding cable under the road. The signals are transferred to the brakes, engine and so on by a form of computer it carries.



**STAMP QUIZ?**

**Do You Know:-**

1. What country puts "C.C.C.P." on its stamps?
2. Does ICELAND issue stamps?
3. Name any country which has issued TRIANGULAR stamps?
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**PRIZES:** We will send you a special prize packet of 25 choice stamps free for each question you answer correctly. 150 diff. fine stamps free (catalogued about £7.50) plus the famous 110-year old British PENNY RED stamp (valued 10p), for 4 correct answers. We will also send you our wonderful New Approvals. Please enclose 5p stamp for postage.

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This outfit will be sent **ABSOLUTELY FREE** if you send us your name, address and 8p postage. We will also send a selection of **SPECIAL APPROVALS** which you can buy for **HALF PRICE (£1)**, purchase just the stamps you want, or simply return the booklet undamaged, but first—ask your parents' advice.

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4. Has TUTANKHAMUN ever appeared on British stamps?

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If there was any form of equipment failure on board, the brakes would be activated again.

As you can see, the system has been designed to be completely foolproof, though the main worry would be getting passengers to accept the fact that they are perfectly safe travelling in a bus with no driver!

the same could be done for transport companies who just wanted to try out the system. Once it had become accepted, automatic buses could be produced on a massive scale.

Though the cost of building each bus would run into thousands of pounds, after a time this would be saved by not having to pay a driver's wages. The cost of laying the guiding cable would be quite low—about £1 a metre (just over £1 a yard). Probably the most expensive part of the whole bus would be the obstacle detection radar at around £300.

One of the few problems at the moment is the fact that automatic buses couldn't detect collisions from cars at the sides. So extensive barriers would have to be built to keep other forms of transport well away.

At any rate, robot buses are now a reality. Automatic systems could be built into new town centre road schemes. Sleek ciberbuses may be carrying people around town in the not too distant future.

## SWITCH-OVER

Even so, buses would be built so that they could be switched over to normal operation at any time. A bus could run automatically through, say, the town centre, and then come under the operation of a driver for the rest of the route through the suburbs.

The bus moves away automatically, picks up speed—it has an automatic gearbox—takes corners and brakes to a halt entirely without driver's control.

The Road Research Laboratory's bus has been converted from an ordinary manual bus, and



12p Weekly No. 87 November 14-21, 1975

# Speed & Power

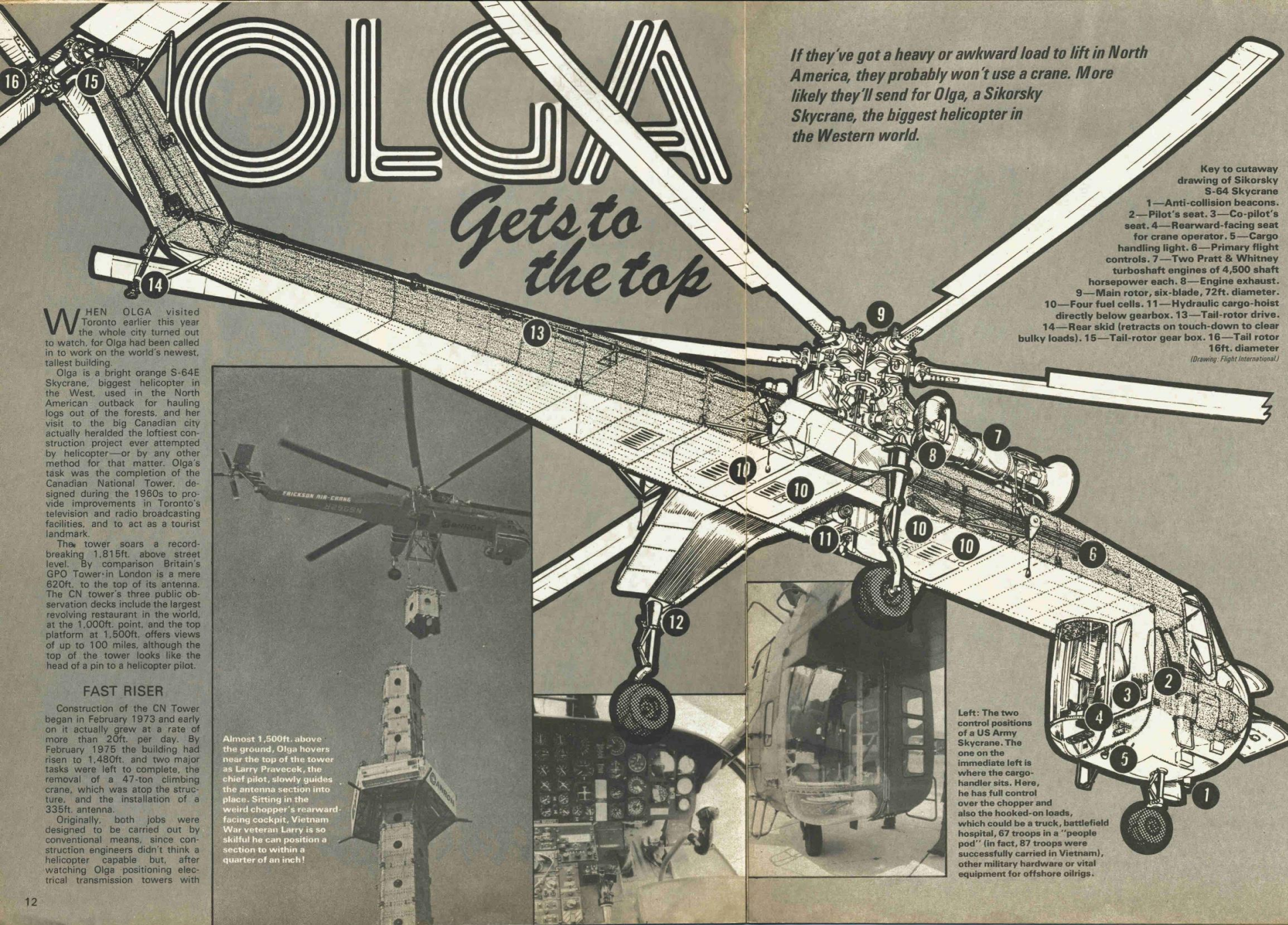


Come fly with us in a  
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**SUPERSTARS  
ON WATER**

**PLANES CARS SHIPS  
HELICOPTERS  
TRAINS**





WHEN OLGA visited Toronto earlier this year the whole city turned out to watch, for Olga had been called in to work on the world's newest, tallest building.

Olga is a bright orange S-64E Skycrane, biggest helicopter in the West, used in the North American outback for hauling logs out of the forests, and her visit to the big Canadian city actually heralded the loftiest construction project ever attempted by helicopter—or by any other method for that matter. Olga's task was the completion of the Canadian National Tower, designed during the 1960s to provide improvements in Toronto's television and radio broadcasting facilities, and to act as a tourist landmark.

The tower soars a record-breaking 1,815ft. above street level. By comparison Britain's GPO Tower-in London is a mere 620ft. to the top of its antenna. The CN tower's three public observation decks include the largest revolving restaurant in the world, at the 1,000ft. point, and the top platform at 1,500ft. offers views of up to 100 miles, although the top of the tower looks like the head of a pin to a helicopter pilot.

## FAST RISER

Construction of the CN Tower began in February 1973 and early on it actually grew at a rate of more than 20ft. per day. By February 1975 the building had risen to 1,480ft. and two major tasks were left to complete, the removal of a 47-ton climbing crane, which was atop the structure, and the installation of a 335ft. antenna.

Originally, both jobs were designed to be carried out by conventional means, since construction engineers didn't think a helicopter capable but, after watching Olga positioning electrical transmission towers with

Almost 1,500ft. above the ground, Olga hovers near the top of the tower as Larry Pravecek, the chief pilot, slowly guides the antenna section into place. Sitting in the weird chopper's rearward-facing cockpit, Vietnam War veteran Larry is so skilful he can position a section to within a quarter of an inch!

*If they've got a heavy or awkward load to lift in North America, they probably won't use a crane. More likely they'll send for Olga, a Sikorsky Skycrane, the biggest helicopter in the Western world.*

## Key to cutaway drawing of Sikorsky S-64 Skycrane

- 1—Anti-collision beacons.
- 2—Pilot's seat. 3—Co-pilot's seat. 4—Rearward-facing seat for crane operator. 5—Cargo handling light. 6—Primary flight controls. 7—Two Pratt & Whitney turboshaft engines of 4,500 shaft horsepower each. 8—Engine exhaust.
- 9—Main rotor, six-blade, 72ft. diameter.
- 10—Four fuel cells. 11—Hydraulic cargo-hoist directly below gearbox. 13—Tail-rotor drive.
- 14—Rear skid (retracts on touch-down to clear bulky loads). 15—Tail-rotor gear box. 16—Tail rotor 16ft. diameter

(Drawing: Flight International)

pinpoint accuracy at a site near Seattle, the towerbuilders changed their minds.

So Olga arrived in Toronto in early March and public interest sky-rocketed. Watching the weird-looking helicopter shuttle up and down the length of the needle tower became so popular that the local newspapers published the daily flight schedules and radio and TV broadcast any cancellations. Special public viewing areas were arranged and the helicopter crew became local celebrities, with TV and newspaper interviews, autograph signing, and real "pop-star" attention.

The tower site was actually in the middle of a sprawling railway terminus which, although scheduled to become a leisure park eventually, was still very much in use. Consequently the Skycrane flights had to be limited to 15-minute periods at pre-determined times, and only vertical flying was allowed, so as to obviate any danger to passing trains and nearby buildings.

Two ex-Vietnam War veteran pilots, "Rip" Green, ex-Sikorsky test pilot, and Dave Korhonen, shared the control duties for the trips up and down the tower. But the most important man on board was the third pilot, Larry Pravecek, Captain of the Skycrane. He took over the flying of the helicopter during the initial load hook-up stages, and also when Olga was within 20ft. of the tower summit, so that he could lower the loads.

## BACK SEAT PILOT

To do all this Pravecek, the holder of 21 Air Medals for Vietnam service, sat all on his own in a rearward-facing load control cab. Here he had at his fingertips all the controls necessary for the manoeuvring of the Skycrane, and the setting down of the heavy chunks of steel within just  $\frac{1}{4}$  inch of the required position and yet at 1,800 ft. up in the sky.

The history-making helicopter project began on March 8 with the first of the seven lifts needed to remove the construction crane. In the meantime the antenna, broken down into 39 sections, was made ready. Each section weighed about seven tons and was positioned on special staging ready for the lifting operations. The topmost section, 32ft. long, was placed on public display, so that the Toronto school children could sign it.

All but the last six of the sections were designed to be set in place by means of a special guiding system, released, and then bolted on after the helicopter had landed. Had there been no delays at all, the Skycrane, with a climb rate of 2,000ft. per minute, could easily have lifted the entire antenna into place in two or three working days, but when you are building at 1,800ft. you need to be extra careful.

Bad weather, particularly high

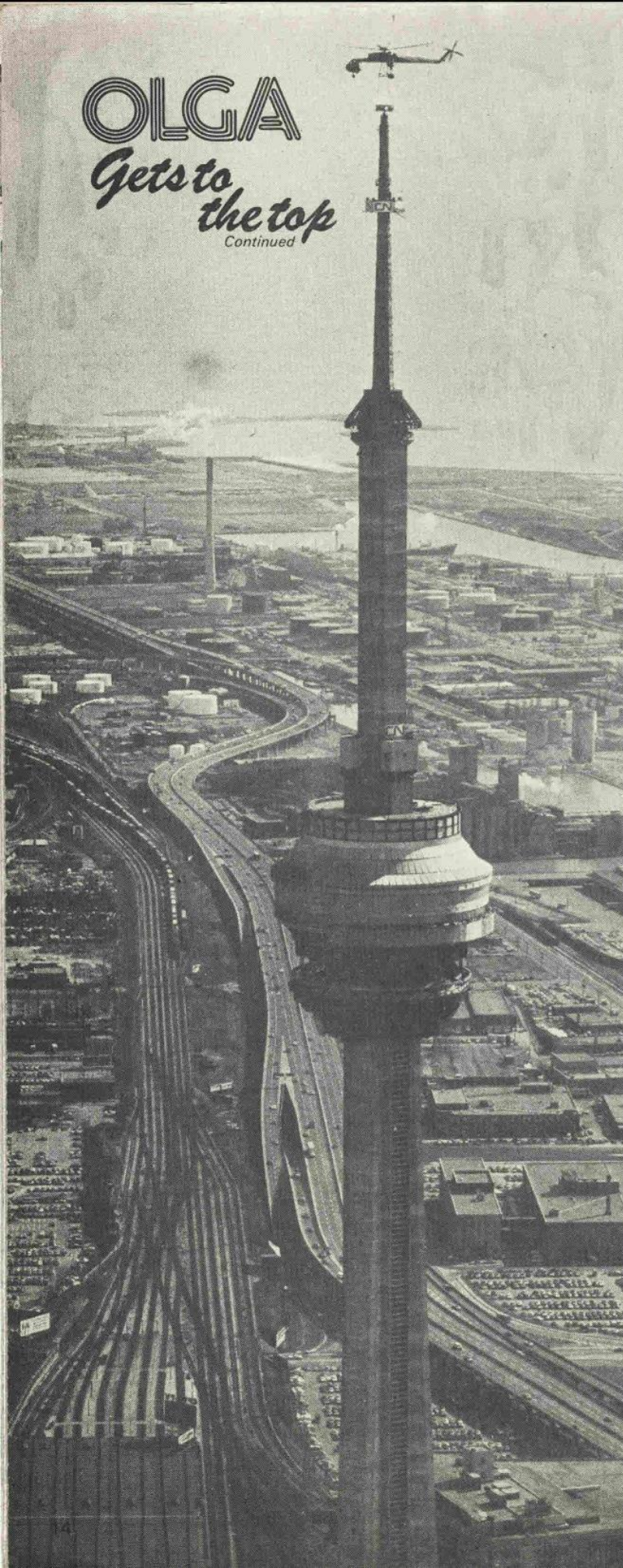
Left: The two control positions of a US Army Skycrane. The one on the immediate left is where the cargo-handler sits. Here, he has full control over the chopper and also the hooked-on loads, which could be a truck, battlefield hospital, 67 troops in a "people pod" (in fact, 87 troops were successfully carried in Vietnam), other military hardware or vital equipment for offshore oil rigs.

CONTINUED ON NEXT PAGE



# OLGA

*Gets to the top*  
Continued



winds and freezing cold, and consequent delays in the bolting operation, prevented lifts on eleven days during the task. Even so, the ironworkers had to work around the clock to keep up with Olga. Five men worked from outside and another five from inside, fitting and tightening up the 40,000 bolts that hold the sections together. A team of painters followed closely behind.

The Skycrane's six-bladed main rotor is 72 ft. in diameter and the blades generate a 200mph blast downward from the tips. This means that the men who hook the antenna sections to the sling had to wear ear protectors, hard hats and padded jackets.

## TOP JOB

The last six sections of the antenna actually had to be held in place by Olga until several bolts were inserted, a job performed by one man—a foreman, who was the only ironworker allowed on the antenna when the helicopter was operating. He maintained contact with aircraft by radio and helped to guide the sections into place. As the project neared completion two ring-shaped dampers were dropped over the antenna to absorb the expected wind vibration and, finally, just 26 days after the operation had begun, Olga made the 55th lift and positioned the last section—complete with its thousands of signatures.

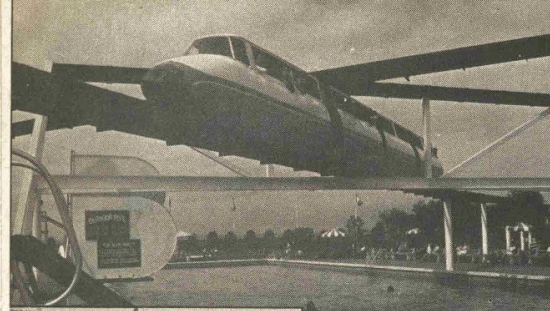
**Far left:** In the blustery conditions 1,815ft. above street level, one false move could send tons of steel hurtling to the ground. **Above:** Because of Olga's tremendous down-draught, all the steelworkers on the CN Tower job wore protective clothing. **Below:** This US Army Skycrane shows how easy a British Army Scorpion tank could be transported to a front line.



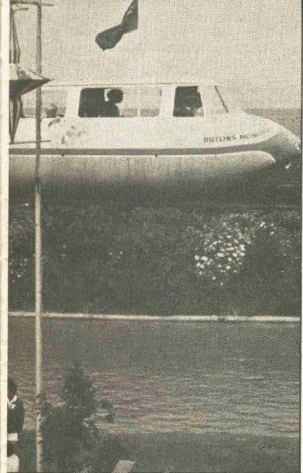
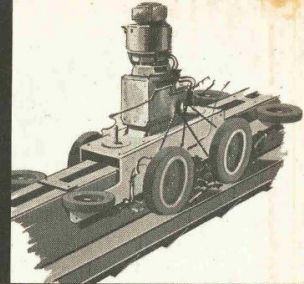




Left: Busy scene at one of the Butlin's Holiday Camps, with two monorail trains crowded with happy holidaymakers taking a ride. The trains were custom-built by Butlin's engineers and are in operation all through the summer season. Below: A four-car monorail train glides over a boating pool at the Minehead camp. The trains run on 110 volts which is fed through wires on either side of the guide rail.



Left: Dramatic low-angle shot of a Minehead train as it speeds over the outdoor swimming pool. Notice the other monorail track which passes overhead. The trains trace a large figure eight around the main buildings. Right: one of the motor units, which use a small electric motor. This drives through chains and various car parts to the drive wheels. The horizontal wheels are used for guiding.



**T**HE MONORAIL is normally associated with huge concrete cities of the future. They're not the sort of thing you expect to see dashing over swimming pools, amusement arcades, boating pools, and people sunbathing. But, if you pay a visit to the Butlin Holiday Camps at Minehead or Skegness, you'll see holidaymakers enjoying free rides on this sophisticated form of transport.

### BIGGEST

Butlin's run the biggest fleet of monorail trains in Britain and have proved that they can carry thousands of people during many hours of continual operation.

The trains have been built by Butlin's engineers, bodywork being constructed from fibreglass. An ordinary electric motor, fixed between cars, provides the drive, through a Triumph car rear axle.

Power for trains is picked up from wires on either side of the monorail. This is a safe 110 volts. "Hubber-tyre" wheels and special centralising rollers keep the trains on the track, guiding them smoothly round curves.

Though the trains only travel

at a speed of six to eight miles an hour, they have an extensive braking system—six drum type brakes positioned along the length of each train—and a handbrake for use at stations.

The control system is rather similar to the old trams—with the same sort of speed controller. This leads through a circuit breaker and resistance bank to the simple transmission.

Butlin's monorails have been in operation for some years now and, though they are quite simple, they have proved to be very reliable and easy to run. Both systems are overhead routes, supported on pillars. The stations are bus shelter type constructions which are reached by footsteps.

### OPERATION

There is no signalling system as such, but the trains run very slowly and sometimes only one is in operation on the line. In operation, the trains are almost silent, apart from a soft "swish" as they glide along the rail.

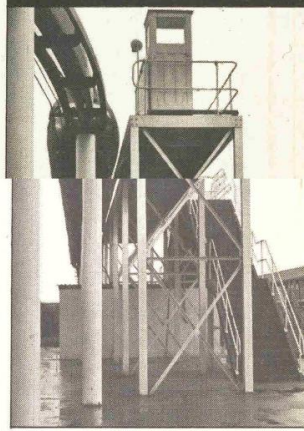
"Inough" this monorail system has been built for fairground-type amusement, they have proved to be extremely reliable and could easily be adapted for public use.

It is not unlikely that in the near future we will see monorails in action above the streets of our towns and cities, ferrying shoppers and commuters around in the same way as London's Underground trains.

It's not often that you get such an important form of transport originating from the light-hearted gaiety of a holiday camp!



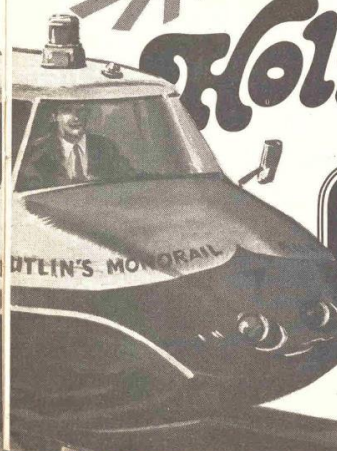
Above: Close-up of a train, showing the driver's cab. Below: All lines are overhead; here is one of the stations at Skegness.





# MONORAIL

Thousands of campers enjoy riding on super monorails during their holiday, but little do they know how important transport systems like this may become...





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# Speed & Power

**CHRISTMAS SPECIAL** 25p





# RUSSIAN EGG ON MARS

Mars 3 achieved the first successful Russian landing on the planet in 1971. The diagram shows: (1) Mars capsule separating from the mother-craft; (2) Capsule engine igniting, to change its course toward the planet's surface; (3) Heatshield used on entry; (4) The parachute opening; (5) Heatshield being jettisoned; (6) Parachute being released and soft-landing rocket switched on; (7) The lander, with unfolded stabilisers, on the planet—touchdown completed.

ON MARCH 12 this year, at the end of an eight-month voyage through space, an egg-shaped metal capsule penetrated the thin atmosphere of the planet Mars, released a parachute and began a 168-second descent to the surface. At the end of the descent it was to have settled softly on to the crater-filled landscape of Mare Erythraeum, a bone-dry "sea" in the southern hemisphere of the Red Planet.

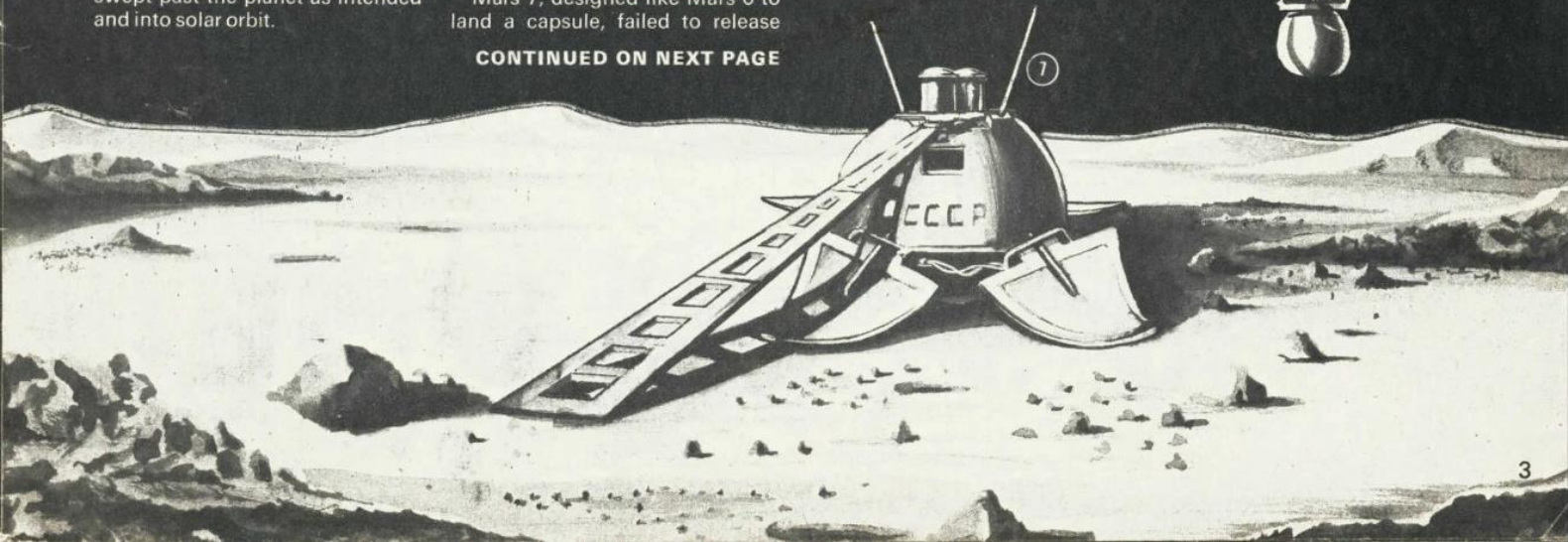
As it fell, the capsule—for the first time in history—transmitted measurements of the Martian atmosphere directly to its creators in the Soviet Union on Earth. But shortly before the touchdown it went mysteriously and completely silent. Its mother craft, Mars 6, swept past the planet as intended and into solar orbit.

High winds, racing over the surface at more than 100mph, may have been responsible for damage leading to a loss of signal, according to theories from American space scientists. The Russians said little, but were clearly disappointed that their "yaitso" (egg) had failed right at the very end of its long journey.

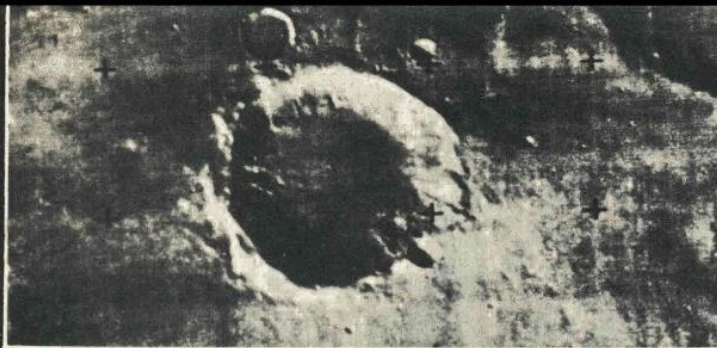
Mars exploration has proved a tough and failure-blighted job for the Russians so far. Mars 6 was one of a batch of four probes launched in the late summer last year. The first of these, Mars 4, was intended to go into Mars orbit, instead it sailed on into solar orbit after its retro-engine failed to ignite at the crucial moment.

Mars 7, designed like Mars 6 to land a capsule, failed to release

CONTINUED ON NEXT PAGE







**Above: A photograph taken by Mars 5, showing a large area of the planet, including a crater 25km in diameter.**

its charge and also went its own way. Only Mars 5, twin to Mars 4, achieved its main objective and swung successfully into its planned elliptical orbit to send back excellent pictures of the terrain below. It also began collecting extensive information on the make-up of the Martian atmosphere and the surface soil, settling down to an operation comparable with that of the American Mariner 9 which performed so well two years ago.

The earlier Russian efforts, too, had mixed fortunes. On the first landing attempt, at the end of 1971, a capsule from Mars 2 crashed onto the surface of the planet, while that of its Mars 3 sister ship achieved a soft landing but stopped transmitting after only 20 seconds. A giant dust storm, at that time covering almost the entire globe, was held responsible. The Mars 2 and 3 parent craft, however, circling in highly elliptical orbits, continued transmitting data satisfactorily for several months.

## STRANGE WORLD

What do we know about Mars after the Soviet and American unmanned flights to this strange world that, in some ways, is more Earth-like than any other planet in our solar system? Mars is about half the size of our planet and has about a tenth of its mass. That means that a 12½ stone man would weigh only five stone on Mars.

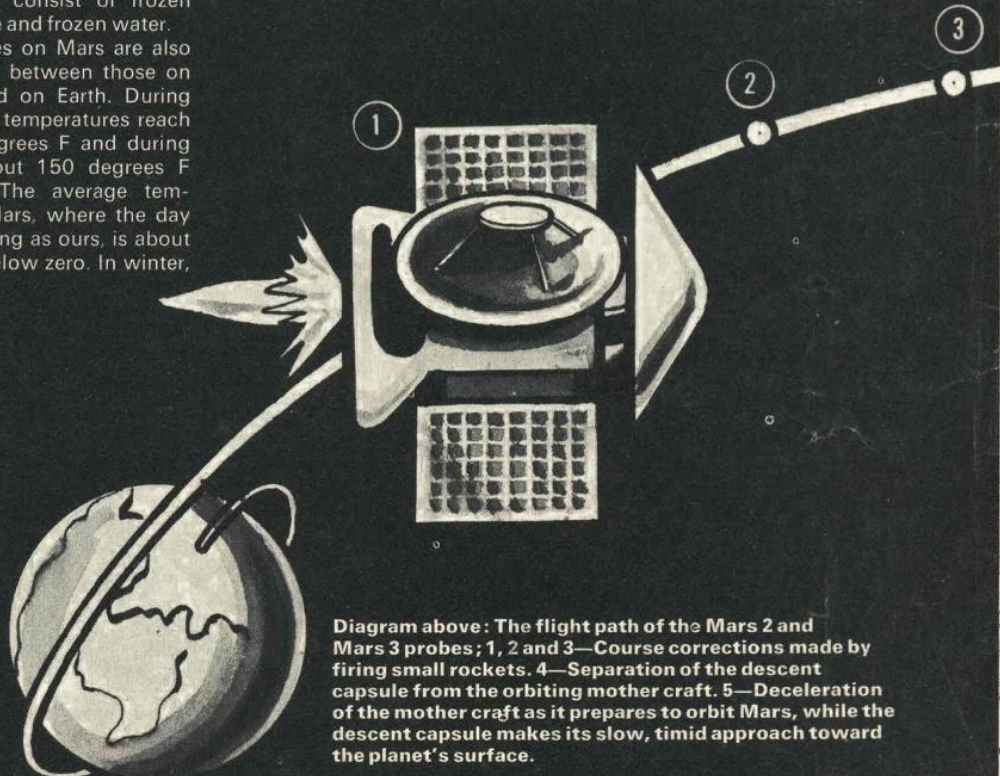
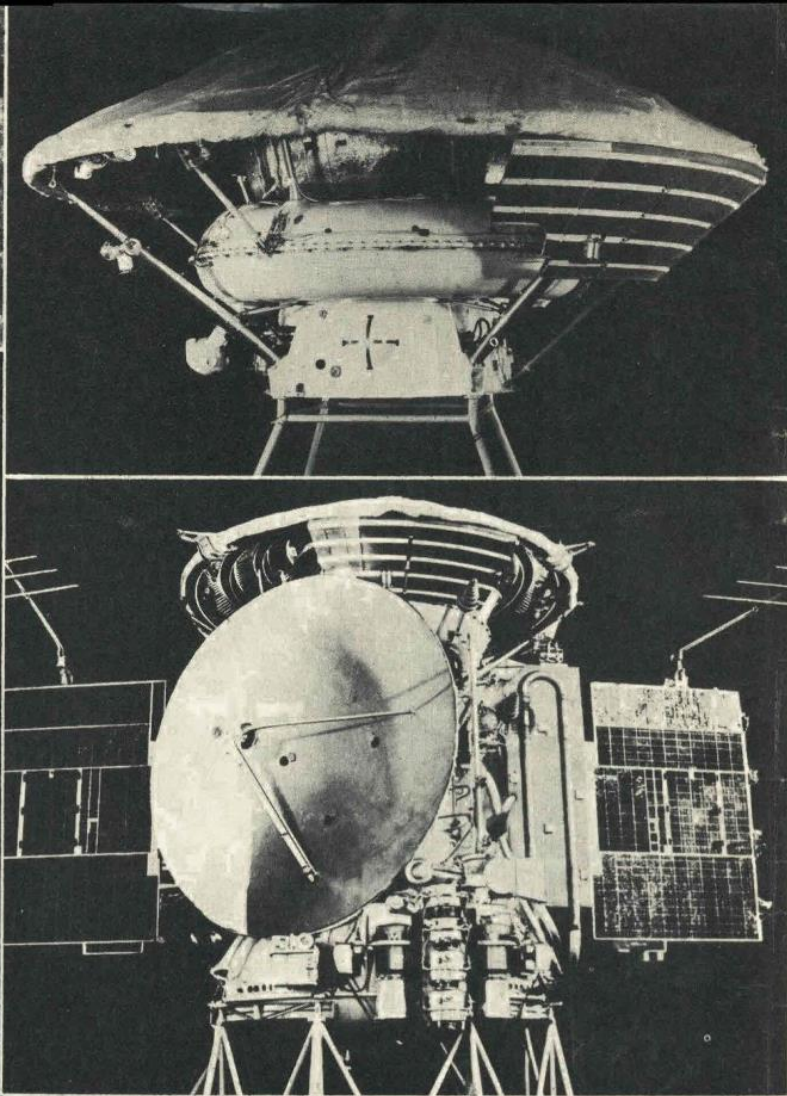
As we already know from the American Apollo flights, the same man weighs just over two stone on the surface of the Moon. So, in this respect, Mars is between the Earth and the Moon. And this goes for many other aspects of Mars. The Moon has no atmosphere at all and the Earth has a pretty dense one of about 15 pounds per square inch. As a result of its low gravity Mars has a very thin atmosphere. It does not consist of about 80 per cent nitrogen and 20 per cent oxygen like that of the Earth, but almost entirely of carbon dioxide. It is

**Above right: The descent capsule of Mars 3, which made a soft landing on Mars late in 1971. Right: The Mars-3 capsule mounted on the main probe. Despite the successful landing, Mars-3 stopped transmitting after only a few seconds, probably because of a giant dust-storm. The orbiting parent craft, however, continued to transmit information to Earth.**

clear that future Mars travellers will have to wear spacesuits and portable life-support systems as the US astronauts did on the Moon.

There is no liquid water on Mars. A glass of water there would boil and evaporate immediately because of the low atmospheric pressure. There are, however, indications that permanently frozen water exists in many places only a few inches below the surface. The Martian polar caps, which melt away in summer, may consist of frozen carbon dioxide and frozen water.

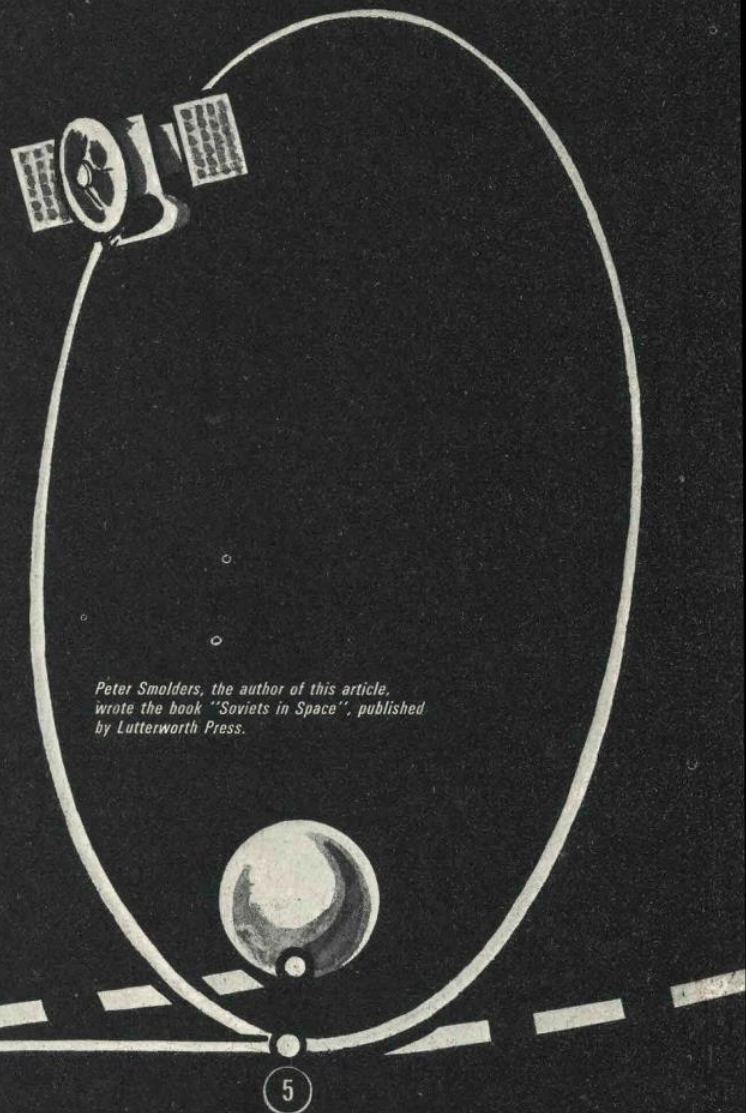
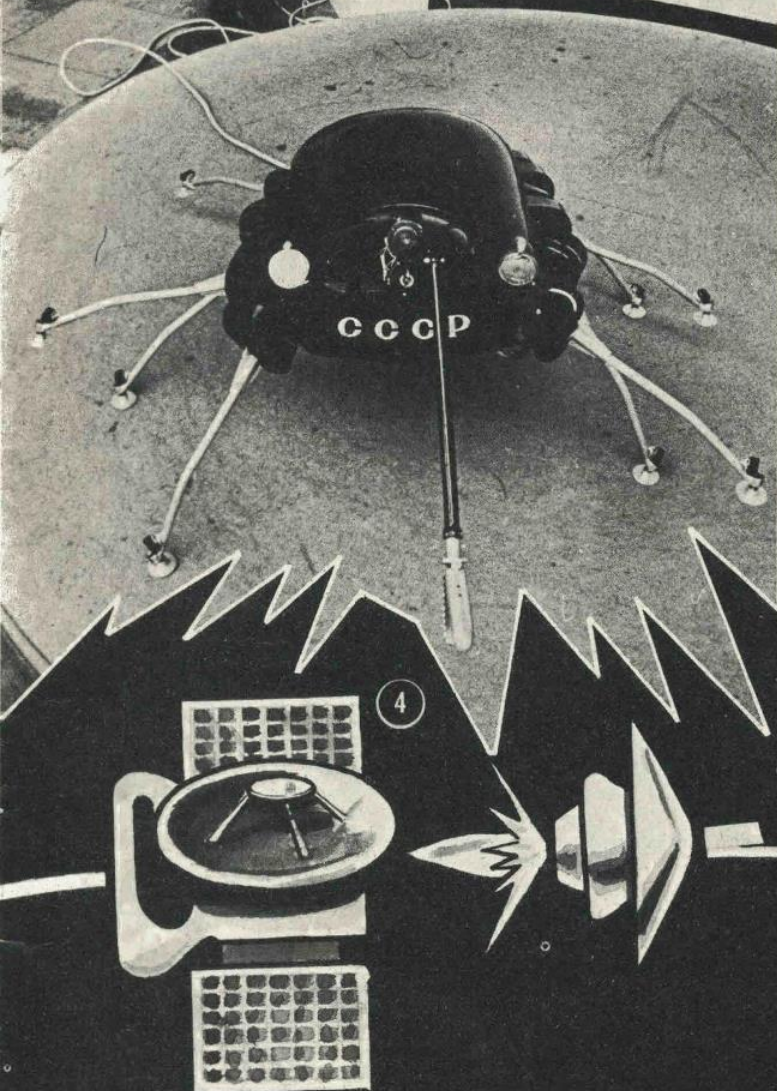
Temperatures on Mars are also somewhere in between those on the Moon and on Earth. During the lunar day, temperatures reach about 270 degrees F and during the night about 150 degrees F below zero. The average temperature on Mars, where the day is almost as long as ours, is about 4 degrees F below zero. In winter,



**Diagram above: The flight path of the Mars 2 and Mars 3 probes; 1, 2 and 3—Course corrections made by firing small rockets. 4—Separation of the descent capsule from the orbiting mother craft. 5—Deceleration of the mother craft as it prepares to orbit Mars, while the descent capsule makes its slow, timid approach toward the planet's surface.**



Pupils of a Russian school built this working "Planetokhod," similar versions of which may be going for "walks" on distant planets in a few years.



Peter Smolders, the author of this article, wrote the book "Soviets in Space", published by Lutterworth Press.

the polar caps may get as cold as minus 190 degrees but, at the equator, day temperatures of plus 60 degrees are common. But when night falls, temperatures there drop sharply to about 100 degrees F below zero.

Could there be life on Mars? Again Mars may prove to be somewhere between the Moon and Earth. While there is abundant life on Earth and apparently none at all on the Moon, any life on Mars might be of very primitive, undemanding forms such as bacteria and very simple plants. These could get their water from the permanently frozen supply below the surface or from the air which contains some water vapour.

An interesting product of the Mars 6 experiment was that the Martian atmosphere was found this year to contain several times more water vapour than it did two years ago when Mariner 9 and Mars 2 and 3 took their measurements. The question of Martian life could be solved when the Americans land their Viking on Mars in 1976. Viking will be equipped with various biological experiments which could provide the answer.

Russian technicians are also working on an unmanned mobile scouting vehicle or "Marsokhod", along the lines of the Lunokhod Moon rovers (see *SPEED & POWER* No.2). Summarising the

problems involved, one of the chief members of the Lunokhod design team said:

"The Marsokhod will differ essentially from the Lunokhod in its present form. In the case of the Moon," he added, "the system exploits two-way communication, so that Man plays the main role. This will be difficult to achieve in the case of Mars because of the immense distance involved." (A radio-command signal from Earth takes just over a second to reach the Moon, but several minutes to cover the distance between Earth and Mars). "There is an atmosphere, so the danger of dust storms cannot be excluded, a danger that does not exist on the Moon. On the other hand, scientists believe that the surface of Mars is less rugged and has less pronounced craters. In any case, it is to be

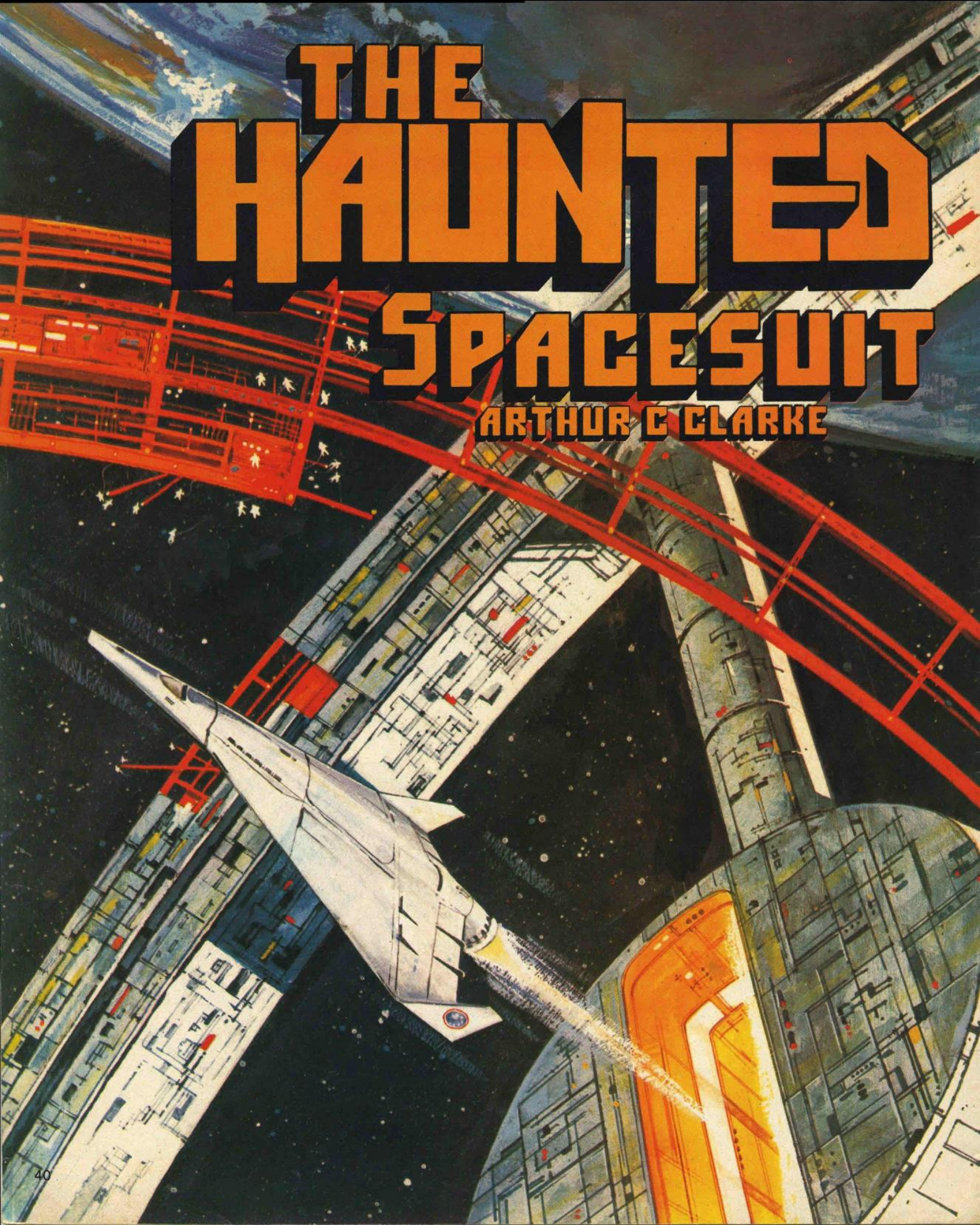
expected that our experience with Lunokhod will be of value in future Mars probes."

What about Men going to Mars? With present technology, a manned flight to Mars is already feasible, but the round trip would take a year or two and would be extremely expensive. Many scientists believe that we should wait until advanced propulsion systems, such as nuclear rockets, are perfected. Even then it might well turn out to be an international project rather than that of a single nation. Soviet cosmonaut Vladimir Shatalov commented on this very issue: "Each flight demands immense financial sacrifices and the problems we face are the problems of all mankind. This certainly applies to the exploration of distant planets, which is not a task for one single country."

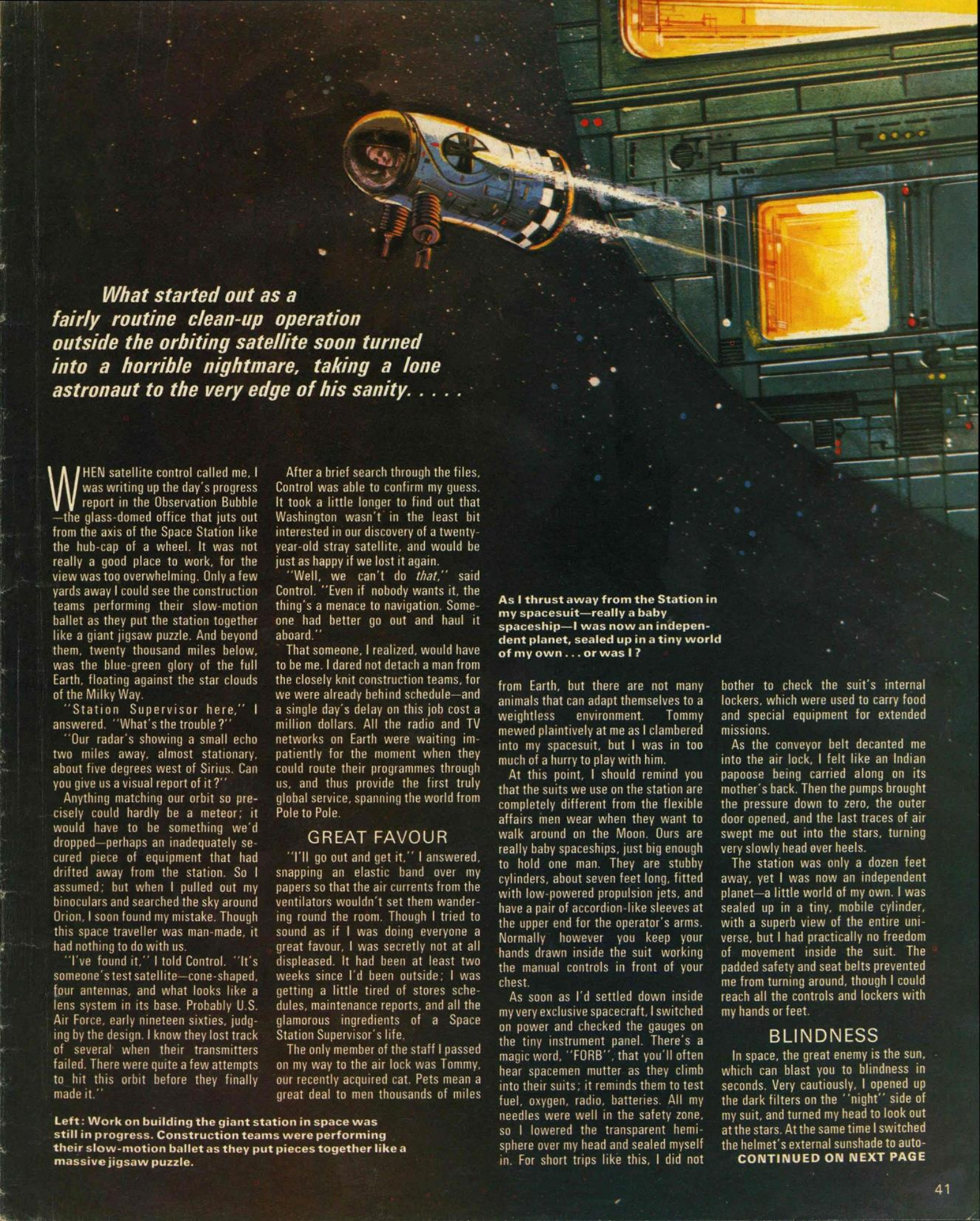


# THE HAUNTED SPACESUIT

ARTHUR C CLARKE







*What started out as a fairly routine clean-up operation outside the orbiting satellite soon turned into a horrible nightmare, taking a lone astronaut to the very edge of his sanity. . . .*

WHEN satellite control called me, I was writing up the day's progress report in the Observation Bubble—the glass-domed office that juts out from the axis of the Space Station like the hub-cap of a wheel. It was not really a good place to work, for the view was too overwhelming. Only a few yards away I could see the construction teams performing their slow-motion ballet as they put the station together like a giant jigsaw puzzle. And beyond them, twenty thousand miles below, was the blue-green glory of the full Earth, floating against the star clouds of the Milky Way.

"Station Supervisor here," I answered. "What's the trouble?"

"Our radar's showing a small echo two miles away, almost stationary, about five degrees west of Sirius. Can you give us a visual report of it?"

Anything matching our orbit so precisely could hardly be a meteor; it would have to be something we'd dropped—perhaps an inadequately secured piece of equipment that had drifted away from the station. So I assumed; but when I pulled out my binoculars and searched the sky around Orion, I soon found my mistake. Though this space traveller was man-made, it had nothing to do with us.

"I've found it," I told Control. "It's someone's test satellite—cone-shaped, four antennas, and what looks like a lens system in its base. Probably U.S. Air Force, early nineteen sixties, judging by the design. I know they lost track of several when their transmitters failed. There were quite a few attempts to hit this orbit before they finally made it."

After a brief search through the files, Control was able to confirm my guess. It took a little longer to find out that Washington wasn't in the least bit interested in our discovery of a twenty-year-old stray satellite, and would be just as happy if we lost it again.

"Well, we can't do *that*," said Control. "Even if nobody wants it, the thing's a menace to navigation. Someone had better go out and haul it aboard."

That someone, I realized, would have to be me. I dared not detach a man from the closely knit construction teams, for we were already behind schedule—and a single day's delay on this job cost a million dollars. All the radio and TV networks on Earth were waiting impatiently for the moment when they could route their programmes through us, and thus provide the first truly global service, spanning the world from Pole to Pole.

## GREAT FAVOUR

"I'll go out and get it," I answered, snapping an elastic band over my papers so that the air currents from the ventilators wouldn't set them wandering round the room. Though I tried to sound as if I was doing everyone a great favour, I was secretly not at all displeased. It had been at least two weeks since I'd been outside; I was getting a little tired of stores schedules, maintenance reports, and all the glamorous ingredients of a Space Station Supervisor's life.

The only member of the staff I passed on my way to the air lock was Tommy, our recently acquired cat. Pets mean a great deal to men thousands of miles

**As I thrust away from the Station in my spacesuit—really a baby spaceship—I was now an independent planet, sealed up in a tiny world of my own . . . or was I?**

from Earth, but there are not many animals that can adapt themselves to a weightless environment. Tommy mewed plaintively at me as I clambered into my spacesuit, but I was in too much of a hurry to play with him.

At this point, I should remind you that the suits we use on the station are completely different from the flexible affairs men wear when they want to walk around on the Moon. Ours are really baby spaceships, just big enough to hold one man. They are stubby cylinders, about seven feet long, fitted with low-powered propulsion jets, and have a pair of accordion-like sleeves at the upper end for the operator's arms. Normally however you keep your hands drawn inside the suit working the manual controls in front of your chest.

As soon as I'd settled down inside my very exclusive spacecraft, I switched on power and checked the gauges on the tiny instrument panel. There's a magic word, "FORB", that you'll often hear spacemen mutter as they climb into their suits; it reminds them to test fuel, oxygen, radio, batteries. All my needles were well in the safety zone, so I lowered the transparent hemisphere over my head and sealed myself in. For short trips like this, I did not

bother to check the suit's internal lockers, which were used to carry food and special equipment for extended missions.

As the conveyor belt decanted me into the air lock, I felt like an Indian papoose being carried along on its mother's back. Then the pumps brought the pressure down to zero, the outer door opened, and the last traces of air swept me out into the stars, turning very slowly head over heels.

The station was only a dozen feet away, yet I was now an independent planet—a little world of my own. I was sealed up in a tiny, mobile cylinder, with a superb view of the entire universe, but I had practically no freedom of movement inside the suit. The padded safety and seat belts prevented me from turning around, though I could reach all the controls and lockers with my hands or feet.

## BLINDNESS

In space, the great enemy is the sun, which can blast you to blindness in seconds. Very cautiously, I opened up the dark filters on the "night" side of my suit, and turned my head to look out at the stars. At the same time I switched the helmet's external sunshade to auto-

**CONTINUED ON NEXT PAGE**

**Left: Work on building the giant station in space was still in progress. Construction teams were performing their slow-motion ballet as they put pieces together like a massive jigsaw puzzle.**





matic, so that whichever way the suit gyrated my eyes would be shielded from that intolerable glare.

Presently, I found my target—a bright fleck of silver whose metallic glint distinguished it clearly from the surrounding stars. I stamped on the jet-control pedal, and felt the mild surge of acceleration as the low-powered rockets set me moving away from the station. After ten seconds of steady thrust, I estimated that my speed was great enough, and cut off the drive. It would take me five minutes to coast the rest of the way, and not much longer to return with my salvage.

And it was at that moment, as I launched myself out into the abyss, that I knew that something was horribly wrong.

It is never completely silent inside a spacesuit; you can always hear the gentle hiss of oxygen, the faint whirr of fans and motors, the sound of your own breathing—even, if you listen carefully enough, the rhythmic thump that is the pounding of your heart. These sounds reverberate through the suit, unable to escape into the surrounding void; they are the unnoticed background of life in space, for you are aware of them only when they change.

They had changed now; to them had been added a sound which I could not identify. It was an intermittent, muffled thudding, sometimes accompanied by a scraping noise, as of metal upon metal.

I froze instantly, holding my breath and trying to locate the alien sound with my ears. The meters on the control board gave no clues; all the needles were rock-steady on their scales, and there was none of the flickering red lights that would warn of impending disaster. That was some comfort, but not much. I had long ago learned to trust my instincts in such matters; their alarm signals were flashing now, telling me to return to the station before it was too late...

### INSANITY

Even now, I do not recall those next few minutes, as panic slowly flooded into my mind like a rising tide, overwhelming the dams of reason and logic which every man must erect against the mystery of the universe. I knew then what it was like to face insanity; no other explanation fitted the facts.

For it was no longer possible to pretend that the noise disturbing me was that of some faulty mechanism. Though I was in utter isolation, far from any other human being or indeed any material object, I was not alone. The soundless void was bringing to my ears the faint but unmistakable stirrings of life.

**As I fought the nightmares I switched to emergency wavelength. "Station! I'm in trouble." Then something soft touched the back of my neck...**



In that first, heart-freezing moment it seemed that something was trying to get into my suit—something invisible, seeking shelter from the cruel and pitiless vacuum of space. I whirled madly in my harness, scanning the entire sphere of vision around me except for the blazing, forbidden cone toward the sun. There was nothing there, of course. There could not be—yet that purposeful scrabbling was clearer than ever.

Despite the nonsense that has been written about us, it is not true that spacemen are superstitious. But can you blame me if, as I came to the end of logic's resources, I suddenly remembered how Bernie Summers had died, no farther from the station than I was at this very moment?

It was one of those "impossible"

accidents; it always is. Three things had gone wrong at once. Bernie's oxygen regulator had run wild and sent the pressure soaring, the safety valve had failed to blow—and a faulty joint had given way instead. In a fraction of a second, his suit was open to space.

I had never known Bernie, but suddenly his fate became of overwhelming importance to me—for a horrible idea had come into my mind. One does not talk about these things, but a damaged spacesuit is too valuable to be thrown away, even if it has killed its wearer. It is repaired, renumbered—and issued to someone else...

*What happens to the soul of a man who dies between the stars, far from his native world? Are you still here, Bernie, clinging to the last object that linked you to your lost and distant*

*home?*

As I fought the nightmares that were swirling around me—for now it seemed that the scratchings and soft fumbblings were coming from all directions—there was one last hope to which I clung. For the sake of sanity, I had to prove that this wasn't Bernie's suit—that the metal walls so closely wrapped around me had never been another man's coffin.

It took me several tries before I could press the right button and switch my transmitter to the emergency wavelength. "Station!" I gasped. "I'm in trouble! Get records to check my suit history and—"

I never finished; they say my yell wrecked the microphone. But what man alone in the absolute isolation of a spacesuit would *not* have yelled when

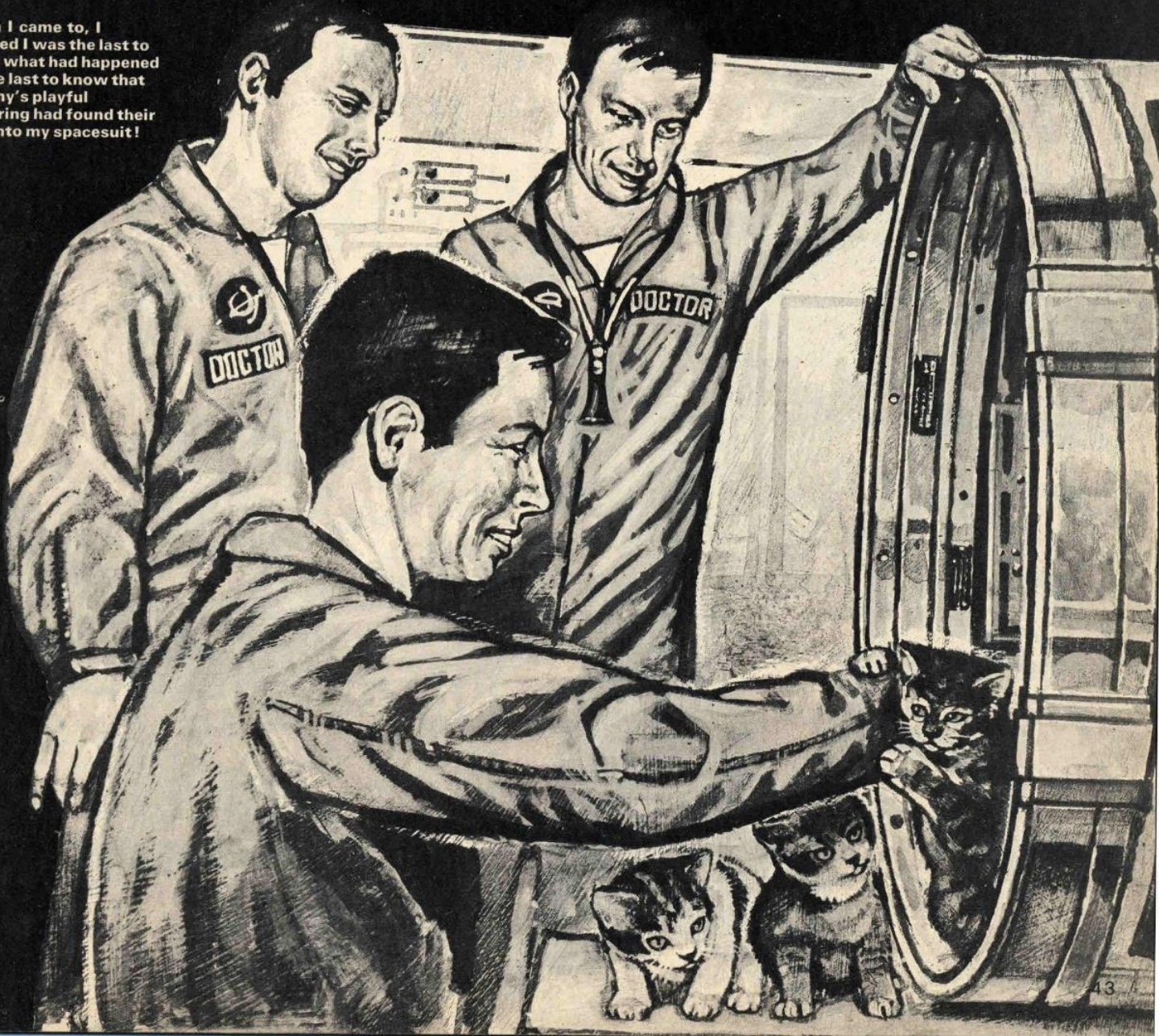
something patted him softly on the back of the neck?

I must have lunged forward, despite the safety harness, and smashed against the upper edge of the control panel. When the rescue squad reached me a few minutes later, I was still unconscious, with an angry bruise across my forehead.

And so I was the last person in the whole satellite relay system to know what had happened. When I came to my senses an hour later, all our medical staff was gathered around my bed, but it was quite a while before the doctors bothered to look at me. They were much too busy playing with the three cute little kittens our badly misnamed Tommy had been rearing in the seclusion of my spacesuit's Number Five Storage Locker.

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**When I came to, I realised I was the last to know what had happened ... the last to know that Tommy's playful offspring had found their way into my spacesuit!**





# **SPEED**

## **ANNUAL**

## **1981**

A  
FLEETWAY  
ANNUAL



*HIGH SPEED ACTION TO MAKE YOU GASP!*



**D**O you believe in flying saucers? If not, you may have to change your ideas before the end of the 1980s for designers are now seriously considering a saucer-shaped craft for cargo carrying — the Skyship. Design of this odd craft, which is pictured here, is on a really big scale — 700 feet in diameter and 208 feet deep at its centre. It will weigh 800 tons and be capable of lifting fuel and a payload of 400 tons. Skyship's lift will be provided by the gas helium contained in 19 gasbags throughout the ship. These will be grouped around a central "core" which will hold the cargo in containers. If backers to Skyship could be found, the project could go ahead at a cost of between 10 to 15 million pounds.

# SKYSHIP!





# FLOATING WORKHORSES!



Nearly forty years ago, the airship Hindenburg was the pride of German airpower. Capable of carrying sixty passengers in a standard of comfort not possible even in today's modern planes, the Hindenburg boasted forty cabins and a dining room. An aluminium grand piano was carried to serenade the passengers as the giant airship plied to and fro over the Atlantic.

On May 6, 1937, when the Hindenburg was only yards from her destination near Lakehurst in the United States, disaster struck. The hydrogen-filled craft suddenly caught fire and the majestic airship was soon reduced to a smouldering mass of twisted metal. Amazingly, no less than sixty-two of the ninety-seven people on board escaped, but confidence in the airship as a safe method of transport was finally destroyed . . . or was it?

In the intervening years scientists in several countries have continued to study airship design and during World War II, the Goodyear tyre company built over two hundred "blimps" as they called them, for the US Navy and Coastguard for use on ocean patrol duties.

The world energy crisis has focused attention on the work of

Like a gigantic flaming torch, the Hindenburg airship crumbled to the ground only yards from its mooring tower in the USA.

designers in Russia, the United States and Britain. They have been working on ideas for giant freight-carrying airships which are claimed to be economical — and also safe. The rapid increases in the price of oil have already resulted in higher air fares and cargo carriage rates, but the search for oil and gas under the North Sea has brought a bonus for the supporters of airships. For the gas helium is a by-product of some of the natural gas which is being discovered on Britain's "doorstep" . . . and it is a safe gas which would prevent another disaster like that which befell the Hindenburg.

Airships have an advantage over conventional aircraft — they can stay up without using their engines, relying solely on the lighter-than-air gas to provide life, whereas an aeroplane would soon plummet to the ground if its engines stopped. So some enthusiasts say it is time to use airships to transport bulky loads which aeroplanes could not possibly manage, and which ships can carry across oceans only at very low speeds.

One exciting plan put forward proposes a fleet of 1,000 huge airships called Transporters, each capable of carrying five hundred tons of cargo. The suggested system is called Merchant Airship Cargo Satellite — MACS for short. The big airships would ply between "Containerbases" on international routes, remaining



"MACS" could each carry 500 tons of cargo on international routes and remain in service for months. Small "service" airships could be used to bring relief crews aboard.





airborne for as long as two months at a time. The crew living on board would operate eight-hour watches, and would be replaced every week by a new crew brought to the airship by a small "service" airship.

The transporter would carry freight from the Containerbases and would be loaded by smaller "Eurolighters" which would ferry the containers up from the base. It is estimated that the Eurolighter could dock with the transporter and unload its container in fifty seconds and then return to the Containerbase with another cargo-loaded container or one carrying ballast.

As well as being cheap to operate, airships could offer other unique advantages. For example, an airship could hover over a factory and pick up heavy machinery, flying it direct to the customer hundreds of miles away. Transporter-sized airships could open up in accessible areas in Northern Canada, Asia and Australia. Oil pipelines carried by airships to remote areas would allow new oil fields to be exploited.

It is certainly easy to understand the enthusiasm of airship advocates, but it is an unfortunate fact of life that many exciting projects have foundered for want of

the odd million pounds or so. Perhaps the airship will rise again from the flames of the past like a Phoenix and prove to be the exception.

Airships could be used as giant cranes, hovering over factories or building sites where heavy loads often need to be moved.

